August/September 1986

# AIR&SPACE

Smithsonian

Fly an airliner into space—
it's the "Orient Express"


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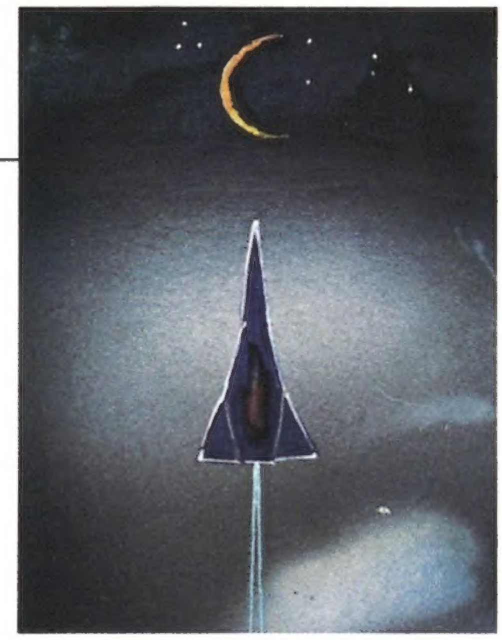
August/September 1986 Volume 1, Number 3

# AIR & SPACE
Smithsonian

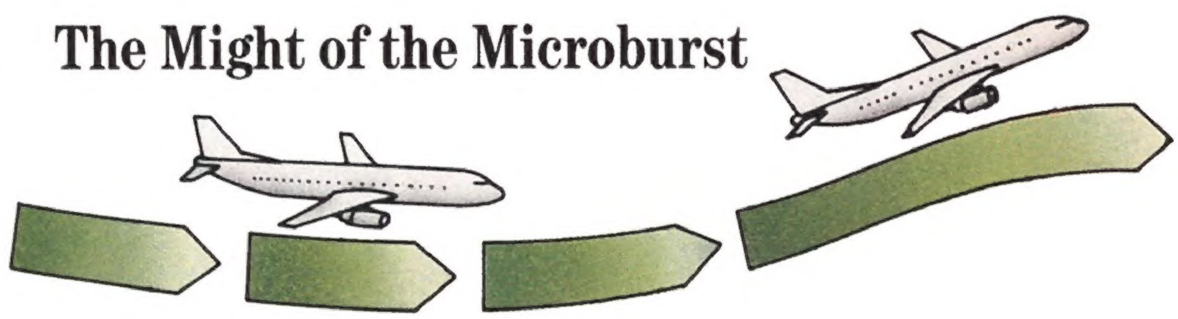
## Contents















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cover: *Barron Storey envisioned a space plane as it might appear at a terminal gate, ready to board passengers for a leap halfway around the world.*

# Westbound

We have just witnessed an extraordinary juxtaposition of two reports of enormous consequence: on June 9, the Rogers Commission, having investigated the explosion of the space shuttle *Challenger*, issued its exhaustively detailed findings; just two weeks earlier, the National Commission on Space issued its vision of what the future of human enterprise in space will look like.

The Rogers Commission delved into the causes of a spectacular failure and reminded us of the need for persistent excellence. The National Commission on Space described a series of goals leading to orbiting space stations and settlements on Mars.

Either report, taken individually, imposes intellectual and emotional demands upon the public. And taken together, they appear to present an irreconcilable view of what is and what must be. But this is a case where appearance deceives; in fact, the two reports are fundamentally complementary.

Had the *Challenger* disaster never occurred and the Rogers Commission never been formed, the organizational review and overhaul of the National Aeronautics and Space Administration's management practices called for in the Commission's final report would still be necessary. The Rogers Commission report, as rigorous as it is, and as difficult as its recommendations will be to implement, will be recognized in 20 years' time as offering a keen and merciful regimen that made further advances possible. Indeed, it would probably be therapeutic to have a similar intensive look into the other bureaucracies—government and industry—that will support the new initiatives in space.

The recommendations made in both reports will be difficult to achieve in the current fiscal climate. The development of a National Aerospace Plane, construction of a lunar base, asteroid mining, and exploitation of non-Earth materials—all these pieces of the picture of our future in space are expensive. And cost will be the central issue to those who oppose the idea of a replacement shuttle orbiter or the development of more ambitious plans.

Cost has always been the rallying point for the nay-sayer and the short-sighted, those whose limited view of economics excludes the cost of lost opportunity. Could anyone today put a dollar figure on the cost had the nation failed to carry out the $15-million Louisiana Purchase in 1803?

We settled the Louisiana territory and pushed westward past its boundaries, multiplying our net national resources well beyond conventional economic calculation. Now the frontier is no longer at the Pacific Ocean but at the distant rim of its basin, where the opportunity for the development of international trade is even greater than the commercial opportunities we seized in developing our own West. And the situation is different.

As the wagon trains moved westward, they faced little in the way of encroachment from either Mexico or Canada. But the development of the market potential of Asia will mean a face-off against competent, fierce competitors already on the scene. Japan carries enormous weight throughout the entire region. The Soviet Union's economic and political presence can't be denied. And China will develop into a formidable power during the time span covered by the Space Commission's forecast.

The economic potential of the development of Asia generates numbers of a magnitude that make the development of the National Aerospace Plane a necessity. If we lack the presence in the Pacific Basin that only this space plane can provide—the marvelous "Orient Express" puts Beijing two hours away from Washington—we will inevitably lose out to either Japan or the Soviets or both.

And curiously, the vehicle itself, almost unbelievable in its promise yet an achievable technological triumph, is not the most important element in this competition. The "Orient Express" is only a lens through which our commercial energies will be focused. It will be the arrow pointing to the future Asian market in the next century.

And make no mistake: there will be an Aerospace Plane. The only question is whose technology will carry the businessmen to their markets and in which direction. Aerospace Planes fly eastbound, too.

—*Walter J. Boyne*

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# FROM MERCURY TO SPACE STATION.

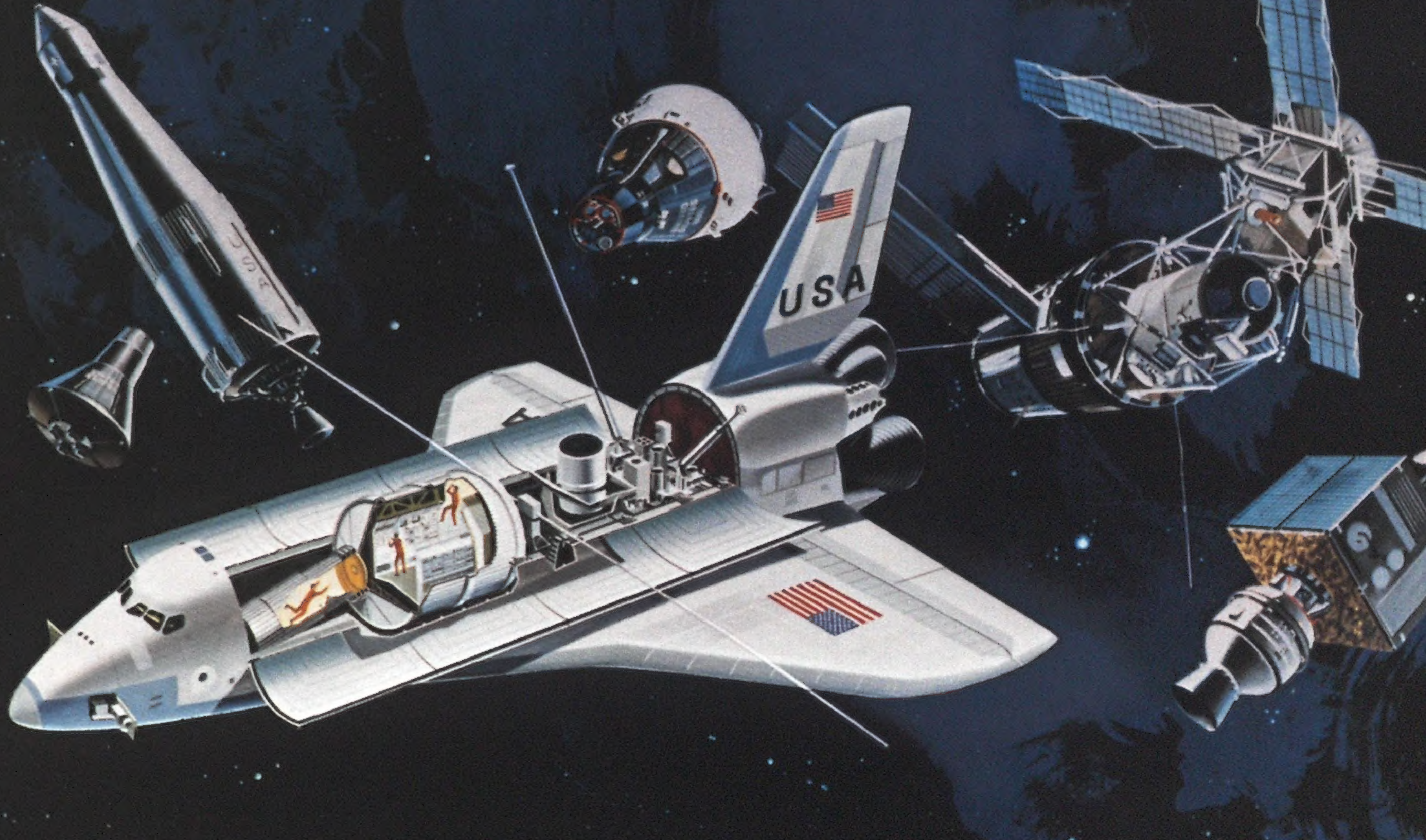
*For sheer thrill of accomplishment for an industrial team, there probably never has been anything to compare with the first flight of the Project Mercury Capsule into space.*

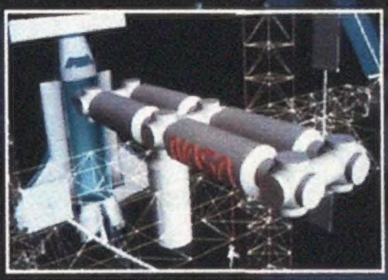
—Our 1961 Annual Report

Since NASA was founded, we have been engaged in an adventure beyond all that civilization had earlier dreamed. Beyond what we could imagine in 1961 when we listened breathlessly to Astronaut Alan Shepard fly our Mercury Spacecraft into history.

McDonnell Douglas support for a human role in space has never wavered. It is dramatically demonstrated by the spacecraft we've provided for NASA—Mercury, Gemini and Skylab, the launch stages for Apollo, and work on the Space Shuttle and its payloads.

Now we are working with NASA to make Space Station a reality. As we celebrate a quarter-century of success and achievement, struggle and sacrifice, we are rededicating our efforts to America's spacefaring leadership.




**MCDONNELL DOUGLAS**

For more information, write: Spacefaring, Box 14526, St. Louis, MO 63178

# Letters

### A Look Back at *Callback*

My first look at *Air & Space* was made memorable for me by Edwards Park's very graceful tribute to *Callback* ("Flights and Fancy"). As *Callback*'s editor, I feel it is my baby and have seldom seen a comment that so accurately summed up my aims in producing it. Since my retirement last fall I have, at NASA's request, been spending two or three days a week at Moffett Field continuing the bulletin. I have also been working at home on, among other things, a *Callback* book.
*Rex Hardy*
Monterey, California

### Controlled Flight

Taking air traffic controllers ("Soundings") in my plane has been an avocation of mine for more than 30 years. It's been very satisfying for me, especially when I've watched their reactions to the instructions they hear from their colleagues on the ground. Every one of them has instantly seen the burden of the lone pilot of a general aviation airplane. I've detected many changed attitudes with these controllers when they later dealt with non-airline aircraft using their airspace.
*Max Karant*
Bethesda, Maryland

### French Guiana's Famous Guest

The watchtower at Kourou ("Ariane") might have kept tabs on Captain Alfred Dreyfus, but he was in no way "infamous," a word that implies evil or treachery. "Unfortunate" or even "wrongly accused" would have been a better choice.

The French made what amends they could by returning him his rank and ultimately promoting him to Major with honors. He served his country during the First World War, and died within the lifetime of many of your readers.
*David J. Rivkin*
Forest Hills, New York

### The Enduring Biplane Controversy

Any article that focuses on the history of the biplane ("The Enduring Biplane," April/May) and doesn't include a reasonably extensive discussion of the Stearman isn't doing justice to the subject. Well over 10,000 Stearmans were produced for the initial purpose of serving as the primary trainer for most American World War II pilots. No other airplane, let alone biplane, can match that record. Yet author Stephan Wilkinson never mentions the Stearman.

Furthermore, while Wilkinson discusses the new Grumman Ag-Cat airplane, he fails to mention the important role Stearmans have played in this arena. Fully 95 percent of the airplanes performing this spraying service have been WWII Stearmans that were purchased after WWII and modified for spraying. Only with the advent of the new Ag-Cats are Stearmans gradually being replaced.

Finally, notwithstanding the fact that the Pitts Special/Christen Eagles are fine airplanes and put on a terrific show, the most common airplane in airshows for aerobatics is still the Stearman.
*C.C. Benedict*
Scottsdale, Arizona

### Hands Off, Kids

As part of my job as a marketing communications administrator for a division of Rockwell International, I read most of the aviation and space-related publications. I do this enthusiastically, since I am also a pilot and a builder of airplanes.

Your new magazine is absolutely stunning; I read it cover to cover. I became an instant fan of Sally Ride ("Above and Beyond," April/May); her piece on the space shuttle was magnificent. I'm tempted to say that she went into the wrong profession.

I received my second issue and secreted it away to keep it from the kids.
*John Giordano*
Cedar Rapids, Iowa

### Space for Air

I would like to cross swords with Mike Michaud of Maryland, who wrote he found the magazine "distressingly unbalanced" in favor of air subjects, and that he hopes "*Air & Space* will not become just another airplane hobbyist's magazine."

Here's a case for the defense of the magazine: since Sputnik introduced the Space Age in 1957 and the Wrights introduced the Air Age in 1903, space is 29 years old, while air is 83. The air age is older than the space age by a ratio of three to one.

The magazine should be called *Air, Air, Air & Space*, and change to *Air, Air & Space* in 2011.
*Dick Alarie*
Putnam, Connecticut

### Shuttle Inquiry

Since the accident of the space shuttle *Challenger* I have been closely following the progress of the Rogers Commission. Now that it has completed its report, I was wondering if you could tell me how I could obtain a copy.
*Tim Mahl*
Chicago, Illinois

*The* Report of the Presidential Commission on the Space Shuttle *Challenger* Accident *(#0-157-336, 1986) is available for $18 from the Government Printing Office, Document Procurement, Washington, D.C. 20401.*

### Deregulation Dissent

It is evident that Joan Feldman ("Airline Deregulation Is Working") hasn't been around or within the commercial aviation

industry for sufficient time to really know the true cost of deregulation. Her statistical snow job does not reveal the frightening decline of safety in the airlines.

I have just taken early retirement from an occupation that I truly loved, that of an airline captain, because of the horrifying erosion of safety. Ms. Feldman says you can't argue with numbers. How about the millions of dollars in fines recently levied against Eastern and American Airlines for maintenance violations? And the big airlines are the ones the government really watches. Think of the plethora of upstart airlines in existence because of deregulation, who are not monitored as closely.

How about an article from an opposing point of view?
*J.T. Miller*
Honolulu, Hawaii

Joan Feldman's "Airline Deregulation Is Working" contained many more half-truths than I care to comment upon. For instance, she failed to mention that People Express has re-thought its entire marketing concept, has never been a profit-making concern, and will probably not be in business much longer without government intervention similar to the FAA loans that enabled them to buy their first airplanes from a foreign airline.

If Joan Feldman had done her homework, rather than parroting the administration's simple platitudes, the outcome of her article would have been quite different.
*E.D. Hoffman*
Middletown, New Jersey

I have received the first two issues of your excellent magazine, but must take issue with "Airline Deregulation Is Working." The matter of deregulation is far from over and it is much too early to claim the experiment a wonderful success.

A simple check of the airplane orders shows that capacity will exceed projected needs as carriers rapidly expand and attempt to control markets. Losses for the first quarter of 1986 were astonishing, and People Express is having substantial problems and is upgrading service. Labor problems are growing rapidly in all sectors as personnel resist new work rules and reduced salaries. Saturation due to hub and spoke operations creates hazardous situations around major airports as air traffic control struggles to keep up, while more and more carriers are being cited for lax maintenance practices and safety violations.

In short, the water is still quite muddy and no clear outcome can be projected.
*John R. Wiley III*
Marietta, Georgia

"Airline Deregulation Is Working" is quite correct when it suggests it takes airline competition to drive fares down. I found this out when I bought a ticket for a flight from Seattle to Nome, Alaska. For the Seattle to Anchorage portion, five competing airlines all have the same round-trip fare of $238, about eight cents a mile. However, for the Anchorage to Nome part of the trip, where Alaska Airlines is the only carrier operating, the round-trip ticket is $426—or about 46 cents a mile. Sounds

*"I'm sorry, sir, but this* is *the no-frills section of the aircraft."*

like they're robbing Peter to pay Paul, and getting away with it.
*Jack Wichels*
Edmonds, Washington

**What's in a Name?**

As he indicated in his letter, Gerald G. Walker is one of many still hanging on to the erroneous theory of the origin of the word "blimp." Dr. A.D. Topping, an expert on the history of lighter-than-air craft, believes the truth can be found in the British magazine *The Aeroplane,* which carried correspondence on the subject between July and November 1951.

In December 1915, Lt. A.D. Cunningham of the Royal Navy Air Service was conducting his weekly inspection of the British airship station at Capel. The station's hangar was constructed with a deep recess in the floor to accommodate the airship car, allowing crewmen and others to walk at the same level as the airship bag. When Lt. Cunningham playfully flipped his thumb against the gasbag of airship SS-12, he was answered with the odd noise that echoed off the taut fabric. Cunningham smiled, then imitated the sound: "Blimp!"

The midshipman commanding SS-12, who later became Air Marshall Sir Victor Goddard, repeated the story of this inspection to fellow officers in the mess later that day. This is now believed to be the true origin of the word "blimp."
*Diane Olrick*
Belleville, Illinois

**In the Dark**

I found Fred Reed's article, "Dark Flight," in your second issue extremely accurate. As an ex-NVG Blackhawk pilot at Fort Campbell, Kentucky, my most satisfying and challenging flying was NVG missions as part of a combat scenario.

Keep writing interesting, informative articles about military aviation. They deserve the recognition.
*Randal W. Lovell*
West Covina, California

Fred Reed's "Dark Flight" brought back a flood of memories from February 1970, when I flew an Air Force CH-3 helicoptor under starlight conditions, using a progenitor of the goggles that Mr. Reed wrote about. After a short but cautious practice session, I was able to hold the chopper in a reasonably steady hover and then take off and land with some trepidation.

Before I left for the West Coast the next morning, I wrote an informal evaluation on the night vision device. About a year later a former colleague told me about the Air Force role in a raid on the prisoner-of-war camp at Son Tay. I was pleased to learn that my evaluation was a valuable part of the planning of the raid.
*Harold L. Miller*
Mesa, Arizona

**Recommended Reading**

I don't generally write letters to editors, but this is one exception since *Air & Space* is so exceptional! The diversity of articles is impressive and justifies reading the magazine from cover to cover, sharply contrasting with the chore of reading some of the dry, technical publications on the market. The article on the NVGs in your second issue, for example, was written in an entertaining style that made for interesting reading. I shudder to think what it would be like to read an article on the same subject written by the "average tech writer"!

I have recommended your magazine to a number of individuals who, like myself, are involved in the cadet aerospace education program of the Civil Air Patrol. Our cadets, who range in age from 12 to 21 years, learn aviation history and military applications of aerospace capabilities in addition to a substantial background in aeronautics and astronautics. *Air & Space* magazine, with its variety of articles on these exact subjects, seems to be tailor-made for our use and I look forward to sharing many more issues with our cadets!
*Kevin M. Jackson*
Monrovia, California

**It's a Boat, It's a Plane**

In response to your subtitle to "When Boats Flew," I would like to point out that the Navy's first airplane, the Curtis A-1 Triad, was not a flying boat, where the hull doubles as the aircraft's fuselage. It was instead a floatplane, which has a float or pontoon in addition to the fuselage.
*William Floyd*
Milwaukee, Wisconsin

Air & Space *welcomes comments from its readers. Letters must be signed and may be edited for publication. Address letters to* Air & Space *magazine, National Air and Space Museum, Smithsonian Institution, Washington, D.C. 20560.*

# Hurricane Busters

The storm that came to be called the Great Atlantic Hurricane of 1944 was born in the doldrums northeast of Puerto Rico on September 8. In the ten days that followed, it would develop 140-mph winds and batter the eastern United States before blowing itself out in the cold waters northeast of Maine. The storm left 27 dead, caused $50 million in property damage, and sank two Coast Guard ships and one Navy destroyer.

Before the war imposed radio silence, ships were able to report developing storms; now, due to fear of enemy submarines, their warnings were stilled. And coastal residents had been asking for a better hurricane-warning system for years. So, early in 1944, the U.S. Army Air Force (AAF) organized a squadron of hurricane hunters, and on orders from General H. H. "Hap" Arnold, four flight crews reported for duty as the First AAF Hurricane Reconnaissance Squadron.

Although some Navy aircraft had been making flights into hurricanes, this was the first organized hurricane-tracking unit ever formed, and I was assigned to one of the crews as a pilot. From bases in Florida and Puerto Rico, we patrolled the hurricane "parade ground" that stretched from the Caribbean to the coastal areas of the Gulf of Mexico and the Atlantic Ocean.

Each crew included a pilot with more than 1,000 hours of flight time, a copilot, navigator, flight engineer, radio operator, and crew chief. A weather officer trained in tropical meteorology flew with us and relayed data to the Weather Bureau's Hurricane Warning Service in Miami.

The squadron flew modified North American B-25D Mitchell bombers. A twin-engine medium bomber, the rugged B-25 was battle-tested and easy to fly in bad weather. With 960-gallon fuel tanks installed in the bomb bay, it could spend ten hours in the air with a full crew. Each airplane was equipped with an APQ-13 airborne weather radar system with a display in the cockpit, a radio altimeter to measure precise height above the wave tops, and a long-range communication radio.

More than a year earlier, on July 27, 1943, Colonel Joseph B. Duckworth, who ran the Army's instrument-flying school at Bryan, Texas, conducted the first recognized flight into a hurricane. He took one of the school's North American AT-6 trainers into a storm near Galveston. Prior to Duckworth's flight, it was thought that sending an airplane into a hurricane meant almost certain death for its pilot. No flying machine, said this line of wisdom, could withstand 100-mph-plus winds, monsoon-like rain, and violent turbulence. But Duckworth had done it and lived to tell the tale. Now it was our turn.

At 5 a.m. on September 12, we left our home base at Morrison Field in Florida, taking off into light rain and a gusty northeast wind. An old fliers' rule says that when the wind is blowing straight at your back, there's a low-pressure area off to your left—so we knew the hurricane was east of us, somewhere over the Atlantic. Other crews had tracked the storm two days earlier, and yesterday's flights placed it 600 miles north of Puerto Rico. But we didn't know how far it had moved during the night. We were to work the storm along with another aircraft, piloted by Captain Allan C. Wiggins, which would depart from Bermuda at noon and approach the hurricane from the east.

A hurricane is extremely large, ranging from 200 to 500 miles across its girth, and generates counterclockwise winds up to 150 mph. Hurricanes move at about ten to 20 mph along a track that takes them north, then northeast as wind currents and the Earth's rotation direct them.

About 200 miles east of our home base and flying level at an altitude of 3,000 feet, we met the first high clouds mixed with rain and some bumpy air. The ocean was roiling with swells and whitecaps. Our plan was to "box" the hurricane: fly east from the coast until we met a wind out of the north, then turn south until we hit a west wind, turn east to run with it until the winds curved around to the south, and so on until we headed for home. In this way, we'd have the luxury of an almost continuous tail wind and would fly around the storm more quickly. We would use the weather radarscope in the cockpit to fly through the "softest" spots in the rain.

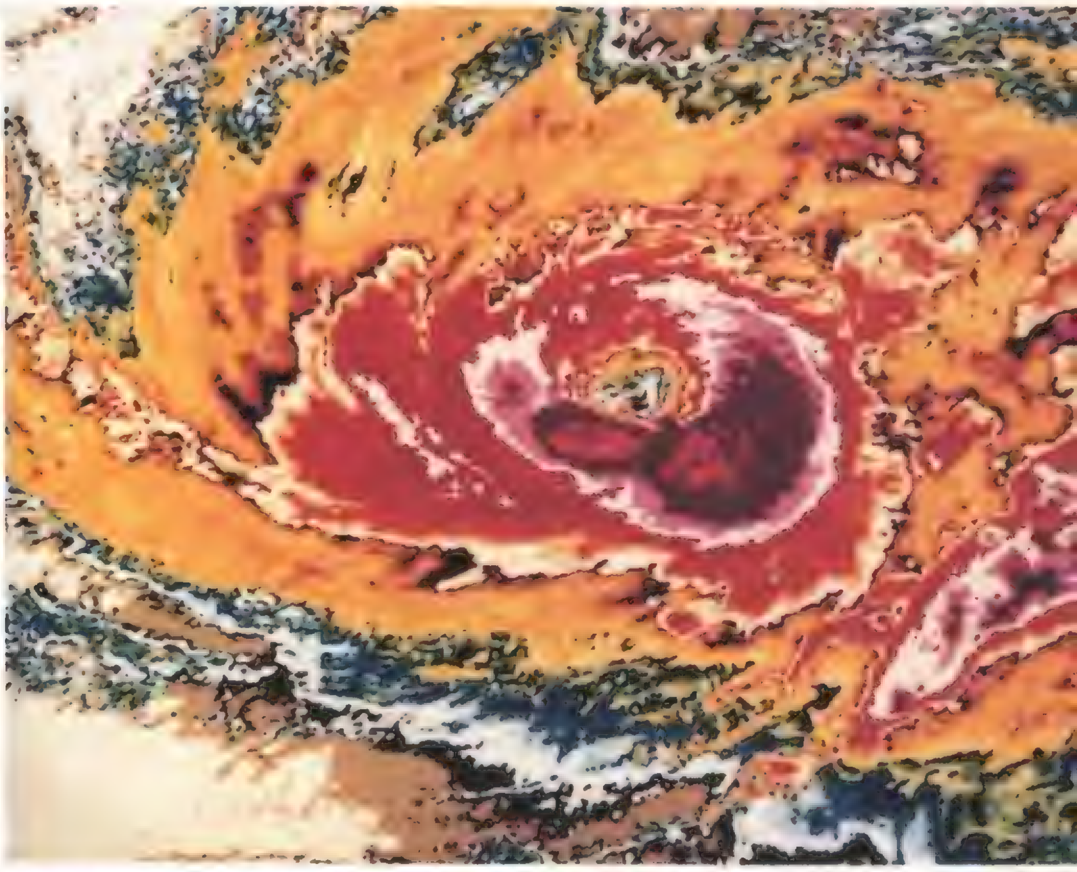
The southwest quadrant of a moving hurricane offers the best flight conditions, while the area most feared by flight crews is the northeast quadrant; that's the front edge of a moving storm, the part that continually meets up with a fresh supply of warm, unstable air. The rain is heaviest there, the clouds blackest, and the turbulence most treacherous. The forward motion of the northbound storm adds to the wind speed in the northeast quadrant, while the same motion is subtracted from wind speed in the southwest quadrant, so a hurricane with 110-mph winds moving at 20 mph has winds of 130 mph in the northeast quadrant. And because you're farthest from home when you're in the northeast quadrant out over the Atlantic, there's a psychological factor that heightens fears.

What we dreaded most were "deck readings"—every 30 minutes, we descended, sometimes as low as 100 feet off the water, until we could see the surface clearly enough to take readings with a driftmeter, a device that measures the airplane's sideward motion due to wind. At the same time, by reading the radio altimeter to determine our actual height above the surface and setting that altitude into the barometric altimeter, we derived a reasonably accurate sea-level barometric pressure. Radioed back to the Hurricane Warning Service, the data helped meteorologists compute the intensity of the storm.

Our readings were showing winds of 110 mph, and we quickly learned that this was an extremely large storm. (We later calculated its size at about 500 miles across.) As we circled the hurricane, we double-checked our exact position by first taking bearings from shore-based radios, then letting the shore-station crews take a bearing on our radio.

When we were on the bottom leg of our "box," we decided this hurricane was just too big to fly all the way around, and the navigator set a new course to the northwest. We would try to fly straight across the vortex and find the storm's "eye"—the calm center where winds die and the sun appears. This new track put us on a direct

National Oceanic and Atmospheric Administration



*The hurricane's vortex (left) is driven by warm, unstable air; colors register the heat in clouds on a satellite's infrared image (right).*

course into the interior region of the storm that is most violent. And as we headed in, the hurricane seemed to concentrate its fury on us.

Water began pouring into the airplane. The engines' cylinder-head temperature was dropping, and so much water was blowing into the carburetor air intakes that we feared the engines might drown and lose power. We closed the air scoops and fed air to the engines through alternate intakes, then reset the fuel-air mixtures. After that, the temperatures stabilized, and the engines roared along happily.

Although the engines were running fine, we began to think the airplane might break apart from the shaking it was getting. But navigator John Bortz apparently didn't share our fears—he ordered another deck reading. Down we went to 100 feet. Below us, we could see a large ship being tossed around like a toy; later, we learned it had been severely damaged.

Back up at 3,000 feet, it took all our attention and my strength as well as the copilot's on the controls to fly in the turbulence. The cockpit lights burned at maximum brightness in the gloom of the storm, and the navigator was hunched down between us, using the radar to find a path that would avoid the worst of the rain. The radio was producing nothing but static, and the gyroscopic instruments were all but useless. We used the back-up instruments, in these conditions the only reliable ones: the rate-of-climb indicator, airspeed indicator, and a simple needle-and-ball gyro instrument that measured rate of turn.

Although the flight conditions told us we must have flown very close to it, our course never took us through the eye of this hurricane. In fact, in the total of ten flights we would make that year, we met up with only one clearly defined eye: it was ten miles across, with birds flying happily and a bright sun shining on a smooth sea.

Finally, after six hours and 30 minutes of flying, we landed back at Morrison Field. We'd spent an hour and ten minutes in predawn darkness, and three hours of the flight had been conducted entirely on instruments. The crew was soaked, the parachutes were soaked, and the airplane was soaked—for hours afterward, water dripped out of it onto the ramp. But the only actual damage we could find was to the propellers, which had lost all their paint to the driving force of the heavy rain.

Later that evening, Allan Wiggins and his crew landed, reporting that the conditions they encountered on the flight from Bermuda had been even worse than ours. They hit the storm's nastiest corner, with winds of nearly 140 mph and turbulence so intense that pilot and copilot together could barely control the airplane. They were wet, tired, and shaken, and the airplane had lost more than a hundred rivets from its nose and the leading edges of the wings.

In the height of a storm, we often wondered, why are we here, flying into this monster? One answer was simple: it was a wartime assignment and better than being shot at. Yet, there was a strange pleasure involved. It was a new chapter in the old battle of mankind against nature. Sometimes, when things got really bad, we would marvel, even if only for a split second, at nature's raw power. Weather, at its most vicious, has an awesome beauty.

As I left the airfield after this day's work, I heard a radio report: "Flight crews report the position of the hurricane. . . . " I felt a little smug—we'd been there. But then I listened attentively: where *was* the storm? I had been too busy flying to ask where we were, and only the weather officer knew the storm's position. At the gate, a guard told me that the hurricane was turning north and would miss Florida. I gave a prayer of thanks.

As hurricane hunters, our B-25s were soon replaced by highflying B-29s and B-50s—four-engine bombers with crews of ten. Eventually, ground-based radar—and later, satellites—took over the job of plotting the storms' tracks. But at the time of those first flights, with no reports coming in from ships, we were the only source of information. I recall the words of Grady Norton, chief of the Hurricane Warning Service: "These fliers are giving the Weather Bureau the kind of service it used to dream about. . . . They have put the Hurricane Warning Service back on its feet this year."

Today, we watch satellite weather maps every night on television. The hurricanes have not been tamed, but their hiding places are no longer a secret.

*—Otha C. Spencer*

# Japan's Blossoming Satellites

Welcome to Tanegashima Island, a tiny jewel off the southeast coast of Japan. A bird's-eye view reveals what seems to be a tranquil, terraced park with winding paths through lush, deep-green foliage, all surrounded by a froth of Pacific surf. But look again—those paths lead from launch pad to blockhouse to control room, where all is far from tranquil when a rocket is about to head into space from Tanegashima Space Center, run by Japan's National Space Development Agency (NASDA).

The Japanese find beauty in all of nature, and believe there ought to be something beautiful in all things made by man as well. "In every facet of life, the Japanese have always devoted themselves to bringing about a sense of peace and harmony, of warmth and comfort, which they feel to be an essential part of beauty," says art historian Joan Stanley Baker in her book, *Japanese Art.* "This quality of beauty that touches them . . . is an inseparable part of life itself."

Illustrations by Paul Salmon

Their space program is no exception. Chu Ishida, an official with NASDA's office in Washington, D.C., smiles and shrugs when asked about the importance of aesthetics in his nation's space efforts, implying with a gesture that it's hard to explain.

But to Westerners, inclined to think of space technology as so many spindly, clunky, metallic objects, the emphasis on beauty can be striking. For example, NASDA's Earth Observation Center, on the main island of Hokkaido, is an orderly garden of ponds and velvety lawns, with a sheltering backdrop of forested hills. Then there's the Kimitsu Satellite Control Center, which might be mistaken for a park except for the full-moon faces of spacecraft-tracking antennas pushing up among the trees.

Another aspect of Japan's aesthetic philosophy is the blending of outside influences with traditional culture. In space, that means East meets West: much of Japan's technology comes from the United States, but develops new facets in migration.

Even things as bland and awkward as satellites acquire a more pleasing nature. American satellites have dull, utilitarian names like Satcom, Syncom, and Spacenet. NASDA names its satellites after flowers—*Himwari* (sunflower), *Yuri* (lily), and *Kiku* (chrysanthemum). But for dealing with Westerners, NASDA uses typically hi-tech names and their inevitable acronyms: Geostationary Meteorological Satellite (GMS), Broadcast Satellite for Experimental Purposes (BSE), and Engineering Test Satellite (ETS), respectively.

Japan has been launching satellites from Tanegashima since 1975, via the N rocket, an oriental version of the U.S. Delta launcher acquired under a technology transfer agreement. (A bigger version, called the H vehicle, is in the works.) The Delta is America's "workhorse," a no-frills way to launch what people in the space business call "plain vanilla" spacecraft—simple communications satellites, for example. Transpace Carriers, the company that markets Delta launch services, doesn't mind the rocket's less-than-snazzy image. "It's not the world's most glamorous vehicle, but it gets the job done," says Transpace spokesman Dennis Ahearn. (Prior to a failure during a May launch, Deltas had logged 43 straight successes over 10 years.) Japan's N rocket has been crafted into a more streamlined version, gleaming white and emblazoned with a huge rising sun. It's the same rocket, but it looks, well, *nicer.*

Don't get the wrong idea, though—Japan has not entered the space race for the beauty of it. The Space Activities Commission, which reports to the prime minister, states that Japan is working toward independence in space: "It will become ex-

tremely important to provide autonomous capability for space utilization in the future advancement of science and technology, as well as improving the national lifestyle."

Robert Lovell, director of NASA's satellite communications division, has worked with the Japanese and says they certainly have "a grand strategy" to become independent in the satellite business. "They're convinced there's money to be made," says Courtney Stadd, an official with the U.S. Department of Commerce who has visited space officials in Japan. Stadd adds that "there's great symbolic value" in space development for Japan—it is a sign of their coming of age, gaining an equal footing with the United States, Europe, and the Soviet Union.

But in the big push to get ahead in space, aesthetic appreciation will not be forgotten. A woman who may become the first Japanese citizen in space is anxiously awaiting her chance to take in the awesome scenery of the heavens. Payload specialist Chiaki Naito, a surgeon by training, says that the main reason she applied to fly on a 1988 Spacelab mission via the U.S. shuttle was to experience the beauty of the Earth from the vantage of space.

—*Linda Billings*

### Dinner with Ken

One regional chapter of the Society of Experimental Test Pilots meets regularly in and around Washington, D.C. At each of these meetings, a guest speaker spins a yarn related to the test-flying business. You'd expect that a group like this had heard it all, but one speaker has made a name for himself as the leading draw of all time.

Ken Weir flies for Lockheed as a civilian test pilot from nine to five and for the Marine Reserves, wearing a general's stars, on weekends. He is a compact, powerful-looking man—the prototypical fighter pilot's build—with a crown of reddish fuzz around the periphery of what must have been a crew cut some years back. He also has flown a lot of hours in the two airplanes that every pilot in the room would most like to have touched just once with the tip of a pinkie: Lockheed's top-secret U-2 and YF-12A, by reputation the highest-flying and fastest airplanes, respectively, in the world.

Weir's after-dinner storytelling centers around some movies and still photographs of both airplanes undergoing tests. Bits and pieces of film have been released over the years, and he has assembled them into a single presentation, supplemented by his own experiences.

There is some rare footage of the U-2 flying from the deck of an aircraft carrier, an event that has all the earmarks of a stunt until Weir explains that it originated in some undefined surveillance mission that took the airplane over water. He gives no details, and throughout the room imaginations spin in silent conjecture.

But Weir is already off on a new tack, describing how some government official had required Lockheed to subject the U-2 to the usual battery of landing-gear torture tests. The clips show the graceful airplane being thumped repeatedly onto a runway, its long wings thrashing in agony to prove its landing gear wouldn't break under the pounding of a hard landing that would ordinarily get a pilot benched. Weir's tone, his choice of words, make it clear he thinks the whole thing was—still is—dumb.

He tells about Francis Gary Powers, who in 1960 was shot down over Russia in a U-2 that experienced an automatic-pilot malfunction. To Weir, this spy plane pilot who had made worldwide headlines was just "Frank," a fellow test pilot and a helluva good guy. (Powers later died in a helicopter accident.) Weir and Powers, both being about the same size, had shared the same flight suit. And Weir explains how the loss of an automatic pilot could allow a U-2 to be shot down.

It turns out that at very high altitude, the airplane's stalling speed and the speed at which supersonic destruction sets in were separated by only four or five miles per hour. Fly too slow, and you stall and spin; fly too fast, and the airplane breaks up. Lockheed solved that problem in later versions, but for Powers, handling the U-2 manually was like walking a tightrope, so an autopilot did the flying—until it broke. Powers descended to reach an altitude where the airplane would be easier to fly, and only then had a barrage of missiles felled him, creating an incident that profoundly embarrassed the Eisenhower administration.

Weir moves briskly along to the YF-12A. Announced to the world in 1964 by President Lyndon Johnson, it was an experimental interceptor capable of sustained flight at three times the speed of sound. Its exact top speed has never been made public, nor will Weir blurt it out tonight. He describes the airplane's systems as one might talk about a favorite Chevy—test pilots, no matter how exotic the fare, never gush at one another.

He also tells of departing in the morning on a sprint from the west coast out to a point near Gibraltar—that's right, the *Rock* of Gibraltar—to rendezvous with a tanker, then turning around and being back home

for supper. He describes the airplane's navigation computer—precise enough to have dropped a bowling ball into a barrel from the YF-12A's operating altitude of more than 70,000 feet (another figure nobody ever seems to pinpoint). All these achievements had taken place in the 1960s, he reminds the crowd.

Ken Weir is a military man, and he has learned to take orders and swallow his personal feelings. He may swallow hard, but there the feelings lie, and Weir's memory of the day in March 1970 when Secretary of Defense Robert McNamara gave the order to scrap the manufacturing tools for the YF-12A still gives him indigestion. Weir recalls how Lockheed's resident-genius designer, Kelly Johnson, incredulous at the order, had tried to hide the irreplaceable tools—until McNamara got wind of it and personally supervised their destruction. Weir says the reason for the move was never divulged to the Lockheed workers, and his voice can scarcely conceal his bitterness at how the tangible achievements of engineers and pilots were so easily erased by a political penstroke.

That two Lockheed airplanes could have flown so high, so fast, and so well—so many years ago—was what filled the room this night. A derivative of the U-2 (the TR-1) is still in service, and a reconnaissance version of the YF-12A (the SR-71) flies for the Air Force, unchallenged, up where its pilots can see the stars in the daytime. Ken Weir has preserved the knowledge and the first-person experience of the development of these truly remarkable airplanes, and his historical caretaking will continue to pack the house for years to come.

—*George Larson*

## *Space Cadets*

Some things you never outgrow: ice cream, puppies, and summer camp. Summer camp? Until recently, those of us over 17 who wanted to sleep in bunk beds and eat mystery meat had to become camp counselors. But now, whether you're a college student or a grandparent, you can go back to camp.

To Space Camp, where you'll play a role in a mock shuttle mission, experience the disorientation felt by astronauts in the zero gravity of space or the super-gravity of launch, and meet some of NASA's scientists—perhaps even a real astronaut. Unfortunately, if you are a grown-up, you're supposed to have important stuff to do, so they won't let you spend the whole summer at Space Camp—you have to compress your fun into three busy days.

The U.S. Space Camp in Huntsville, Alabama, is operated by the Alabama Space and Rocket Center and is located practically in the shadow of its display of Atlas and Redstone rockets. And, for an added touch of authenticity, just down the road is NASA's Marshall Space Flight Center, which Space Campers can visit.

The camp started in 1982, with week-long sessions for high-school students. The success of that program—youth sessions are frequently booked months in advance—inspired expansion. "So why do we have the big kids [meaning grown-ups]?" Space and Rocket Center director Edward O. Buckbee asks rhetorically. "There are a whole lot of adults out there who want to fly in space. We decided we should share this program with them."

It was a good decision: now entering its second season, the $400-per-camper adult program already rivals the youth version in popularity.

Upon arrival, the 40 or so campers are divided into two teams, "Discovery" and "Atlantis." Each camper gets a flight suit (lots of Velcro here) and a name tag—all very official-looking. Then the fun begins: campers "train" during the first two days, using equipment such as the Free Access Trainer and the Moon Walker.

The trainer is a chair, suspended from the ceiling, which rotates freely on several axes. Wearing harnesses, campers use their arms and legs to rotate, hang upside down, or simply stay upright, depending on their coordination. The walker is another seat-and-harness contraption, this time suspended from giant springs, so a camper attempting to "walk" seems to have lost more than 80 percent of his body weight and goes bounding across the floor.

Campers also rehearse for their shuttle mission, reading through detailed scripts.

Everyone has a part to play. Some are members of the shuttle crew: they sit in an orbiter mock-up, with checklists, switches, and flashing lights arrayed before them. Others are ground crew, working in a miniature "mission control room" with computer terminals, countdown clocks, and giant display screens that show films of actual shuttle missions. The simulation begins at nine minutes before liftoff and proceeds through launch, satellite deployment, Spacelab experiments, re-entry, and landing. There are also contingency plans, in which teams cope with "emergencies" (failed engines and cabin fires, for example) that camp counselors can—and invariably do—program into the "mission."

On their final day, team members run through the full two-hour simulated mission—then graduate, with diplomas.

Perhaps the most enjoyable aspect of going to camp as an adult is that the camp counselors are younger than the campers. (Most counselors are college students majoring in aerospace-related fields.) When they say you don't have to do anything you don't want to, you can believe them. In fact, if sleeping in bunk beds is just a little too, well, campy, you can always pitch camp at a hotel just 100 yards down the road.

And about the food: although the young campers are subjected to "astronaut food," adults dine at very respectable buffets and barbecues.

Real food. A good time. Yes, you can go back to camp.

—*Katie Janssen*

## *Through the Looking Glass*

"We can fly in airplanes and look *out* into the sky, but we're still enclosed—we're never alone with just the sky. Once, I had a dream where the environment allowed you to see nothing *but* the sky."

Howard Rosenthal's dream became reality for a year or so, but is now an orphaned vision in need of a new home. He created a huge sculpture called "Sky Disk," an interactive work of art in which the only players are the observer and the sky itself. The walk-in sculpture, 47 feet wide and 10 feet tall, resembles from the outside a giant saucer into which, at any moment, a matching teacup will be set. Inside, the walls and floors are lined entirely with mirrors, so that all one sees are reflections of the sky, surrounding the observer in a vast blueness and the clouds of the moment—depending, of course, on the weather.

Rosenthal is a 38-year-old sculptor living in the crunch of lower Manhattan—raised in Queens—whose art deals largely in such reflections. "The idea of transposing the elements—earth and sky—intrigues me," he says, "and mirrors help facilitate that idea." After Rosenthal reflected on Sky Disk for several years, the sculpture was finally constructed three years ago in a field in the potato-growing community of Calverton, on Long Island, under the flight path of airliners inbound to Kennedy International Airport from Europe.

The owner of the land, Leo Stern, was in the process of planting evergreen saplings that would grow into a sign, 1,700 feet by 300 feet, heralding his Swiss Motel to the passengers above. "Leo was creating his own work of art—a sign that could be seen only from the sky," Rosenthal says. "I was building a sculpture from which you could only see the sky." It was kismet.

The two artists worked side-by-side on their projects, while F-14 fighters from the nearby Grumman aircraft plant thundered overhead and helicopters sprayed the surrounding fields against potato bugs. With friends and assistants, blood, sweat, and tears—not to mention his own money—Rosenthal slowly put together the wood-and-glass Sky Disk. The site was zoned for commercial use (wood-framed structures prohibited), so Rosenthal had to present his case to the town board, which granted him a one-year "temporary open-air exhibition" permit. He also consulted with an engineer to calculate the size of the panels ("it would have taken me years to figure it out on my own"), with a fellow sculptor on using bracing cables, and with Bay Shore Glassworks, which cut and installed the glass.

Finally, Stern felled the lone tree that could be seen from within the sculpture, and Sky Disk debuted on a hot August afternoon in 1983. Even the sky cooperated, with a splendid batch of cumulus clouds.

Visitors had to remove their shoes before entering. Clouds rippled across the segmented mirrors, cascaded down the

panels, spilled onto the floor like waterfalls. Judging from the comments, the sculpture was well-received:

"It's magical . . . beautiful."

"The endless dimensions . . . nothing above, nothing below."

Not all visitors were as pleased. "One woman came on a day when there was nothing but blue overhead, and was really quite angry that there were no clouds on the mirrors," Rosenthal says. "She seemed to think that clouds were guaranteed.

"It can be extremely dramatic, theatrical, when the clouds and the sky are bright," he continues. "But it can be quiet and contemplative on a gray day. It brings the sky much closer to you—you're never more than 40 feet from a cloud. That's one of the things art does: it allows you to see the world in new and better ways."

Rosenthal has even spent occasional nights beneath the stars in his creation. "It was spectacular," he says, "like being in a glass spaceship. I rolled off my sleeping bag one night and found myself looking *down* at the sky. Magnificent."

The *New York Times* ran a story about Sky Disk, as did several Long Island newspapers, and people from all over pilgrimaged to the sculpture. Seen from the road, just a short walk from a car, it was its own advertisement, a UFO abandoned in the middle of hundreds of acres of potato plants, with no explanatory sign. "Surprisingly, it didn't get very dirty inside, except when the potatoes were harvested, which kicked up dust—and potato bugs," Rosenthal says. "I cleaned it from time to time with water and ammonia."

But without fences or security or anyone in attendance, vandalism was perhaps inevitable—beginning with children breaking the panels with rocks—and in the summer of 1984, Stern sealed up the sculpture to protect visitors from broken glass. With no funds to replace the glass and build a security system, Sky Disk was dismantled in October 1985 and remains in storage.

"It can be rebuilt," says Rosenthal. "I've always thought it would be best situated on government property, where it could be guarded and maintained. It would have to be elevated, though, above the line of sight of any buildings or trees that would interfere with the reflection of the sky. But it would be a permanent work of art to benefit generations to come."

Meanwhile, Stern's evergreens grow into a fine "Swiss Motel" as the clouds and airliners come and go overhead.

*—Patricia Trenner*

## Dry Reading

Fire destroyed much of the Los Angeles Central Library in late April of this year, causing more than $1 million in damage. After firefighters quenched the blaze, the librarians were faced with a soggy problem: 700,000 water-logged books. Fortunately for the city's book lovers, engineers at McDonnell Douglas Astronautics in nearby Huntington Beach came to the fore with a simple, albeit hi-tech solution.

The company offered the services of its Space Simulation Laboratory, a mainstay in testing spacecraft components in various atmospheric conditions, as a glorified drier. A month after the fire, 20,000 of the books were ready to be re-shelved.

The company had its first experience in drying earthbound papers about a year earlier, when some of its payroll records incurred water damage during a move. North Selvey, manager of the Space Laboratory, was called in to solve the problem.

"Now they always call me when something gets wet," says Selvey. "We have also helped some of the local libraries on a small scale, but we never tackled a job like the Central Library. This was the first—and hopefully the last—really large book-drying project we've undertaken."

The laboratory, essentially a chamber 39 feet in diameter, was developed during the space boom of the early sixties. It has been used for testing all manner of spacecraft components, from those on the Saturn rocket to Skylab. At the flick of a switch, engineers can simulate conditions ranging from sea level to 500 miles into space.

In orbit, spacecraft are subjected to super-hot and super-cold conditions simultaneously. By surrounding components in the chamber with panels cooled by liquid nitrogen to -320 degrees Farenheit, and at the same time creating very high temperatures with heat lamps, Selvey and his crew can test the components under realistic deep-space conditions.

To dry the books, the chamber was calibrated to simulate the atmosphere at an altitude of 110,000 feet. This reduces the atmospheric pressure from 14.7 pounds per square inch to 0.1 pounds per square inch, the optimum for speedy vaporization. (At lower pressures, the water would freeze.) As atmospheric pressure decreases, so does the temperature at which water boils. After vaporizing, the water molecules collect on super-cooled steel plates within the chamber and turn into ice. Engineers then melt the ice and pump the water from the chamber.

The books, which had been quick-frozen after the fire to prevent mildew, were left in the chamber for more than two weeks. By the time the books had dried out, the system had removed 700 gallons—three tons—of water.

"The amount of water was almost more than our system could handle," says Selvey. "It really wasn't designed with this sort of problem in mind. It made a mess of the laboratory. Nonetheless, we are very pleased with the results."

Betty Gray, director of the Los Angeles Library, recently reported that McDonnell Douglas' generosity had already saved taxpayers thousands of dollars. The remainder of the books will have to wait in the deep-freeze, though—Selvey and his associates have a backlog of space-bound items to test in the chamber, including instruments for communications satellites and the next generation of spacecraft.

"We're fully booked for the next 18 months," Selvey says ruefully, "but first we have some mopping up to do."

*—Sean Henahan*

## *Update*

**Cessna Aircraft Company**, citing increased liability costs and decreased market demand, announced on May 28 that it has suspended production of all piston-engine aircraft until October 1987 at the earliest. "Response to our Hangar 10 stores has been almost overwhelming," says Dean Humphrey, director of public relations at Cessna ("Soundings," April/May), "but because of this suspension of production, we are taking a very hard look at our plans for the program—where to go, what to do, what to salvage."

**The Ariane rocket program** ("Ariane," June/July) has suffered a setback with the failure of the first Ariane 2 rocket during a May 30 launch. Ariane 1s and 3s have been used on 14 successful launches. Arianespace had planned four more launches for 1986, each carrying satellites to orbit, but coupled with the failures of the U.S. Titan and Delta rockets, all commercial launches are on hold.

**Geostar's Link 1** positioning and communication service, scheduled to begin operation in September ("Soundings," June/July) has also suffered a setback. Primary and backup receivers on the radio relay device, launched in March on an Ariane rocket, have failed, and a $2.4 million total-loss claim has been filed with the insurer. The launch of a replacement relay device depends on how Arianespace chooses to reschedule the backlog of payloads.

**Shuttle launches** from Vandenberg ("Spaceport West," April/May) could be delayed until 1989 because of problems at the facility, including engine exhaust ducts that could trap explosive hydrogen gas, according to a report prepared for the Senate. A Vandenberg spokesman says rebuilding the ducts would be "an immense effort," but the Air Force is optimistic that a quicker solution can be found.

**The illustration** for "Professor Lewis's Doughnuts" (April/May) could use some clarification. According to recent census information, more than one area in the United States has cities with populations of 20,000 or more, which would have come as a surprise to anyone reading the diagram's legend. Here is the correct key for the illustration on page 109 of the premier issue.

*Circle City*

*Cities with populations of 20,000 or more*

*Regional urban constellations*

Phil Jordan

# Featherwaste

Like many pilots, I have always envied birds for doing naturally what I had to learn. I delight in their swooping chandelles, graceful lazy-eights, and the precision of their spot landings. And I marvel at the tight formation of pairs of chimney swifts that flash around my roof like the Blue Angels—even though I know it's sex, not flying, that's on their minds. But my respect for birds as fliers has been badly shaken.

I felt the first tremor when my brother-in-law had a strange experience with geese. He's a sailplane pilot, and one fall day he was browsing over a ridge in New Hampshire hunting for some decent lift when he had the sudden feeling of being watched. He looked to his left and spied a dozen Canada geese flying in echelon on his wing. He looked to his right: more Canadas. He was heading south, and so were they. The honkers apparently latched onto him because they figured his sailplane was so big it *must* know where it was going.

So geese may not be all that great after all. They can louse up their navigation like any flier, then stumble around the sky, only too happy to dump the burden on someone—or something—else. I'm forced to conclude that the gabbling you hear as a skein of Canadas wings overhead is merely an endless goosian argument about taking the lead:

"*You* take it."

"Not me, buddy. You keep it."

"Let's make Mikey take it. Hey, Mikey! You take the lead!"

And so on and so on—gabble, gabble, gabble—every *Branta canadensis* assiduously avoiding the hot seat.

The story led me to look more critically at birds, and I've discovered plenty of clay feet among my idols. A few years ago, we had a pair of baby falcons at the Smithsonian, raised from infancy by Cornell University ornithologists. It was hoped this nurturing would help them make it out there in the cruel world, where the native species was all but extinct. How exciting it would be, we all agreed, to have falcons soaring above the Mall, pirouetting with each other in half-rolls, the way falcons do, and occasionally whistling down to zap the odd pigeon. I could barely wait until they began flying school.

Well, they turned out to be the worst student fliers I've ever witnessed. Their handlers would chuck them off the parapet of the Castle's highest tower and they would flap and scrabble around the sky, their falcon instruments nothing more than a blur of tumble, whir, and dither. And when it came time to land, these exalted examples of *Falco peregrinus* would invariably come in downwind, hot as a pistol, and then ground loop, barking a wing tip on a battlement. My old primary instructor would have washed them out on the spot.

The falcons were mere babes and might be excused for their ineptitude. But other birds that should know the ropes seem to get entangled in them anyway. Albatrosses and gooney birds of the family *Diomedeidae* cruise for so long over the Pacific waves that when it comes time to nest, they have utterly forgotten how to land. John W. Aldrich of the U.S. Fish and Wildlife Service once described the scene at Midway Island, a known meeting place for the species: "Speed's too great. Landing gear collapses. In a flurry of gyrating wings and disheveled feathers a bird sprawls across the ground . . . as crowds of recent arrivals stand by, squealing, groaning, and clapping their bills."

Another bird, the Australian rainbow lorikeet, flies like a dream when sober. The trouble is, he spends all day drinking the fermented nectar from flowering trees. When he flies home at closing time, he's one clobbered *Trichoglossus haematodus.* He and his mates wander off course, yelling at one another amid frequent midair collisions. How he survives I don't know. It's one endless bashing every evening, then back to the pub first thing in the morning.

Then there was the matter of the straw-necked ibis. I watched one stooging around over a wooded swamp beside a golf course one afternoon, and I postponed a typically catastrophic iron shot to see what he was up to. He was scouting the marshy ground from a level glide just below the trees but above the underbrush.

Then he spotted dinner—probably a frog, or *grenouille naturelle* in his eyes. This ibis yanked himself around in an impossibly tight bank and literally spun in. One moment a portrait of natural grace, he was in the next instant transformed into a cartoon of flying feet, twisting neck, and wildly flailing wings. He crashed ignominiously in the bushes but was back in the air in seconds. *Threskiornis spinicollis* acted as if nothing had happened, but I noticed the look on his face and knew the feeling.

Some birds really hate to fly; it's just too much effort. For instance, during my bloodlust days of extreme youth, I went moose hunting in Canada and met up with a spruce partridge. *Canachites canadensis* is dark and handsome, but simply can't be bothered with all that flapping. Oh, it will hop up into a tree, but that's about it.

My companion and I had planned to do a bit of pot shooting for our meals. But the "fool hen," as Canadians call it, refused to budge so that we could blast it like true sportsmen. Instead, it would wander up to us, clucking away, and we ended up using the barrel of the shotgun to fend it off. Its passive resistance won the day—not to mention that from such close range there wouldn't have been enough left to make a morsel of hash.

Many pioneers of aviation, including Smithsonian Secretary Samuel P. Langley, sought to learn the secrets of flight from gulls and vultures and eagles and other paragons of flying elegance. There are some people who say they'd have been better off studying birds of a more uncertain bent: the over-cautious, over-confident, forgetful, lazy, or those in need of a little more instruction. They might have learned the most from New Zealand's kiwi. Its kindly environment makes so few demands that it doesn't have to fly at all. So it doesn't.

But then again, consider the dodo, which never learned to fly. It's now extinct.

*—Edwards Park*

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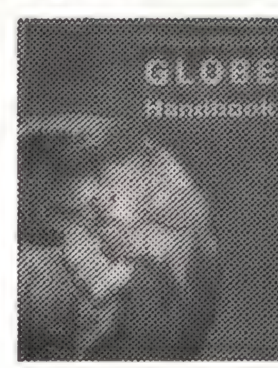


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# Anniversaries and Events

**1783**
**August 27** A 12-foot-wide hydrogen balloon released in Paris ascends to 3,000 feet and drifts 15 miles to descend in Gonesse, where it is attacked by villagers who believe it is an evil-smelling airborne monster.

**1871**
**August 19** Orville Wright is born in Dayton, Ohio (see Events).

**1893**
**August 1-4** The first international air conference is held at Chicago. Speakers include Octave Chanute and Samuel Langley.

**1908**
**September 9** Lieutenant Frank P. Lanham becomes the first official airplane passenger in a 6-1/2-minute flight with Orville Wright at Fort Myer, Virginia.

**1909**
**August 22-29** The first international air meet is held at Reims, France, where more than 20 aircraft and 28 pilots compete in speed, distance, and duration events to the cheers and applause of thousands.

NASA


*Earth's greatest hits, aboard the* Voyagers, *are offered to alien music lovers.*

**August 27** Captain Peter N. Nesterov of the Russian Air Force performs the first loop, in a Nieuport Type IV over Kiev.

**1923**
**August 21** Airways in the midwestern United States are illuminated by electric-arc beacons, visible for 50 miles, placed on 42 landing fields.

**1924**
**September 28** Two U.S. Army Air Service Douglas World Cruisers, the *Chicago* and the *New Orleans*, arrive in Seattle to complete the first round-the-world flight. Four World Cruisers departed Seattle on April 6 for the 27,553-mile flight. The *Boston* made a forced landing in the Atlantic; the *Seattle* crashed in Alaska.

**1929**
**September 24** Guided only by a radio beacon and cockpit instrumentation in his Consolidated NY-2 biplane, Lieutenant James Doolittle makes the first "blind," or instrument, takeoff and landing at Mitchel Field, New York.

**1934**
**August 2** A Wright-Eaglerock departs Floyd Bennett Field, New York, towing three gliders destined for release over Philadelphia, Baltimore, and Washington in the first "airplane train," a scheme of questionable design arranged by the Lustig Sky Corporation. Strong winds force down the procession 2-1/2 hours after departure.

**1939**
**August 27** The first turbojet-powered aircraft, a Heinkel He 178V1 with a HeS-3b engine designed by Hans von Ohain, is flown by Erich Warsitz at Marienehe airfield in Germany.

**1940**
**August 19** The Civil Aeronautics Administration awards an honorary pilot's license to Orville Wright on his 69th birthday "in recognition of outstanding service rendered in advancing the science of aeronautics." (Wilbur Wright died in 1912.)

**1959**
**August 7** NASA launches *Explorer 6,* which sends back the first satellite photo of Earth taken from space.

**September 12** The Soviet Union launches the *Luna 2* space probe, the first man-made object to land on—or more accurately, smash into—the moon.

**1966**
**August 10** NASA launches *Lunar Orbiter 1,* which returns high-resolution photographs of potential Apollo landing sites.

**1974**
**August 26** Charles Lindbergh, 72, dies in Maui, Hawaii.

**1977**
**August 13** The space shuttle prototype *Enterprise,* carried to 22,800 feet by NASA's Boeing 747, makes its first free-gliding flight and lands on Rogers Dry Lake at Edwards Air Force Base, California.

**August 23** The *Gossamer Condor,* a 70-pound aircraft with a 96-foot wingspan designed by Paul MacCready and piloted by Bryan Allen, wins the £50,000 Kremer prize for the first human-powered aircraft to fly a one-mile figure-eight course.

**September 5** *Voyager 1* is launched. With sister ship *Voyager 2,* launched on August 20, it is the fastest spacecraft to traverse the solar system. Traveling at an average speed of 33,500 mph, the probes will eventually pass Pluto to become interstellar messengers. Both carry a gold-plated record containing 90 minutes of Earth's greatest music, from a Brandenburg concerto to "Johnny B. Goode," leading to one speculation that the first extraterrestrial transmission may be "Send more Chuck Berry." (See "Groundling's Notebook.")

**1978**
**August 11-17** The helium-filled *Double Eagle II,* flown by Maxie Anderson, Ben Abruzzo, and Larry Newman, becomes the first balloon to cross the Atlantic. The *Eagle* departs Presque Isle, Maine, and lands near Miserey, France, 137 hours later, to a welcome as fervent as Lindbergh's reception in Paris 41 years earlier. Altitude ranges between a low of 3,500 feet when cloudy skies cool the gas, causing the balloon to sink, and a high of 24,950 feet.

**1982**
**September 1-30** H. Ross Perot Jr. and Jay Coburn make the first round-the-world flight by helicopter in a Bell 206L-1 LongRanger II, *The Spirit of Texas,* to and from Fort Worth.

**Events**

**Through August 10**
*"America's Space Truck: The Space Shuttle"* (Smithsonian Traveling Exhibition). Fort Lauderdale, Florida, at Discovery Center (305)462-4115 and Pensacola, at Cordova Mall (904)477-5462.

**Through August 31**
*"Twenty-five Years of Manned Space Exploration"* (Smithsonian Traveling Exhibition). Tampa, Florida. At Museum of Science and Industry (813)985-5531.

**Through October 13**
*"Expo 86" World's Fair.* Vancouver, British Columbia. Aviation Week Aug. 1-10; Abbotsford International Air Show, Abbotsford, Aug. 8-10; Hot Air Balloon Festival, Langley Airport, Aug. 29-Sept. 1; Lighter-Than-Air International Exhibition Sept. 22-28. (604)689-1986.

**August 1-8**
*Experimental Aircraft Association 34th Annual Convention and Sport Aviation Exhibition.* Oshkosh, Wisconsin. Close to 20,000 aircraft and a million visitors make Oshkosh one of the world's premier aviation events. Italian National Military team Frecce Tricolori, Goodyear blimp, Christen Eagles aerobatic team, Marine Corps Harrier, NASA "21st Century Aviation" exhibit. At Wittman Field (414)426-4800.

**August 1-17**
*XIII World Aerobatic Championships.* Cirencester, England. The U.S. team will defend the Nesterov team trophy, won at the 1984 biennial competition. At South Cerney airfield, about 75 miles west of London. Mike Heuer, International Aerobatic Club (901)756-7800.

**August 2-September 1**
*"Black Wings: The American Black in Aviation"* (Smithsonian Traveling Exhibition). New York, New York. At Floyd Bennett Field, Ryan Visitors Center (718)338-3408.

**August 2-September 7**
*"Early Flight: 1900-1911"* (Smithsonian Traveling Exhibition). Fort Wayne, Indiana. At Old City Hall Historical Museum (219)426-2882.

**August 5-10**
*"Astrocon 86."* Baltimore, Maryland. 40th annual Astronomical League convention for amateur astronomers. At College of Notre Dame. (301)686-3165 evenings.

**August 6-7**
*Space Construction Conference.* Hampton, Virginia. Review of the EASE/ACCESS space structures experiment (with the participating astronauts present) and future

Don Berliner

*The US Aerobatic Team hitchhikes to the World Championships on a USAF Galaxy.*

Christopher Springmann

*Gentlemen, start your balloons: more than one hundred will race at Reno.*

plans. Hosted by NASA Langley Research Center (804)865-4834.

**August 6-9**
*Mercury Conference.* Tucson, Arizona. Discussions on recent scientific advances concerning the planet Mercury and plans for future Earth- and space-based studies. At Ventana Canyon Resort. Sponsored by Lunar and Planetary Institute, University of Arizona (602)621-2902.

**August 8-10**
*Abbotsford International Aviation Exhibition and Airshow.* Abbotsford, British Columbia. *Concorde*, Red Arrows, Snowbirds, Blue Angels, Golden Knights fly against the backdrop of the Cascades. At Abbotsford Airport (604)859-9211.

**August 8-15**
*34th Annual Antique Airplane Association Fly-in.* Blakesburg, Iowa. The world's oldest antique/classic aircraft fly-in. At Antique Airfield (515)938-2773.

**August 10-15**
*International Flying Farmers Convention.* Colorado Springs, Colorado. At Clarion Hotel. IFF (316)943-4234.

**August 11-15**
*17th Annual International Aerobatic Championships.* Fond du Lac, Wisconsin. Competitors from at least six countries are expected. At Fond du Lac Skyport. Clisten Murray, International Aerobatic Club (618)566-8601.

**August 12**
*Perseid meteor shower.* Two to four hours before sunrise. *

**August 15-17**
*Fun Fly.* Ida Grove, Iowa. More than 400 giant scale model aircraft, representing all eras of aviation. Christen Eagles, World War II aircraft, skydivers, NASA exhibit. At Lake LaJune Estates. (712)364-3165.

**August 18-20**
*Second NASA Symposium on the Space Station.* Washington, D.C. Project status, configuration and uses, human productivity, and future space exploration will be discussed. At Omni Shoreham Hotel. Pamela Edwards, American Institute of Aeronautics and Astronautics (212)408-9778.

**August 19**
*National Aviation Day.* Commemorates the birth of Orville Wright in 1871.

**August 23-24**
*"Flight '86" airshow.* Schenectady, New York. Skydivers, wingwalkers, BD-5 jet, Blue Angels, current military aircraft static display. At Schenectady County Airport. (518)382-0041.

**August 30-September 1**
*Cleveland National Air Races and 57th Annual Cleveland National Airshow.* Cleveland, Ohio. Both records and airplanes were broken regularly at the Cleveland Air Races in the 1930s and '40s. Blue Angels, Golden Knights, Eagles aerobatic team. At

Burke Lakefront Airport. (216)781-0747.

**August 30-September 28**
*"America's Space Truck: The Space Shuttle"* (Smithsonian Traveling Exhibition). Windsor Locks, Connecticut. At New England Air Museum (203)623-3305.

**September 1-13**
*World Parachuting Championships.* Ankara, Turkey. Teams from approximately 40 countries will compete. Mike Truffer, U.S. Skydiving Team (904)736-9779.

**September 3-5**
*AIAA/Space Station in the 21st Century.* Reno, Nevada. Seminars, panel discussions, lectures. At MGM Grand Hotel. Sheila Butler, American Institute of Aeronautics and Astronautics (212)408-9740.

**September 3-7**
*Farnborough International Air Show.* Farnborough, England. World's current military and commercial aircraft. Visitor's Bureau telephone 011-44-1-730-3450.

**September 5-7**
*Great Reno Balloon Races.* Reno, Nevada. More than 100 hot-air balloons will compete in this fifth annual celebration. At San Rafael Park. (702)786-1181.

**September 9-November 8**
*"America's Space Truck: The Space Shuttle"* (Smithsonian Traveling Exhibition). Hickory, North Carolina. At Catawba Science Center (704)322-8169.

**September 11-12**
*"Law and Life in Space."* Grand Forks, North Dakota. International conference on the commercialization and ethics of space, satellite communications, and space law. At University of North Dakota Center for Aerospace Sciences (701)777-2791.

**September 11-14**
*23rd Reno National Championship Air Races.* Reno, Nevada. Considered the premier air-racing event in the United States today. Highly-modified World War II fighters race at more than 430 mph in the world's fastest motor sport. Thunderbirds, Bob Hoover. At Stead Airport. (702)826-7500.

**September 11-October 15**
*"Airborne: Aerial Photography."* Grand Forks, North Dakota. Photography exhibit, including Landsat photos. "Capturing the Aerial Image" lecture opening day. At North Dakota Museum of Art, University of North Dakota campus (701)777-4195.

**September 13-October 12**
*"Jupiter and its Moons"* (Smithsonian Traveling Exhibition). Fort Myers, Florida. At Nature Center of Lee County (813)275-3183.

**September 19**
*"Microwave Astronomy: Revealing the Invisible Universe."* Kansas City, Missouri. Lecture by Ronald D. Ekers of the National Radio Astronomy Observatory, Socorro, New Mexico. Sponsored by Sigma Xi Scientific Research Society. At Helen F. Spencer Performing Arts Center Theater, University of Missouri, 7:30 pm. Tickets required (816)276-2704.

**September 20-October 19**
*"Twenty-five Years of Manned Space Exploration"* (Smithsonian Traveling Exhibition). Frankfort, Kentucky. At Kentucky State University (502)227-6852.

**September 20-October 19**
*"Black Wings: The American Black in Aviation"* (Smithsonian Traveling Exhibition). New York, New York. At Bronx Community College (212)220-6366.

**September 22-24**
*"Symposium '86."* Atlantic City, New Jersey. Lunar development and magnetic levitation transportation. At Resorts International Hotel/Casino. (609)589-4090.

**September 24 and 25**
*"The Space Shuttle."* Lecture by astronaut Sally Ride, NASA Johnson Space Center. Sponsored by Sigma Xi Scientific Research Society. Tickets required. New Brunswick, New Jersey, Sept. 24, at Rutgers Gymnasium, 7 pm. (201)524-4218. Towson, Maryland, Sept. 25, at Goucher College, 7:30 pm. (301)337-6333.

**September 27-November 2**
*"Early Flight: 1900-1911"* (Smithsonian Traveling Exhibition). Greensboro, North Carolina. At Greensboro Historical Museum (919)373-2043.

** Call the Smithsonian "Earth and Space Report" for recorded information on astronomical events at (202)357-2000.*

*Organizations wishing to have events published in "Calendar" should submit them at least three months in advance to Calendar,* Air & Space *magazine, Room 3401, National Air and Space Museum, Washington, DC 20560. Events will be published as space allows.*

*—Patricia Trenner*

# The Spy Plane that Came in from the Cold

When the National Air and Space Museum opened its "Looking at Earth" display in May, the undoubted centerpiece was a sleek metal aircraft with impossibly long wings—a Lockheed U-2, certainly the most politically explosive airplane series in aviation history. The first airplane constructed for the express purpose of spying on other countries, the U-2s were catapulted into international headlines when Soviet missiles downed one piloted by Francis Gary Powers over a collective farm in the Soviet Union on May 1, 1960.

It was no ordinary airplane that caused so much diplomatic strife. Created by famed airplane designer Clarence L. "Kelly" Johnson, whose past work included the P-38 Lightning and the Constellation airliner, the U-2 (U for "utility," in an attempt to mask its spy purposes) was constructed to reach altitudes long considered unattainable by any conventional aircraft. At its ceiling of over 70,000 feet, the spy plane could cruise serenely over a country, confident that no available technology could shoot it down—until that fateful day when Francis Gary Powers bailed out of his cockpit and into a diplomatic uproar.

Department of Defense

*The U-2: a black bird with eyes sharper than an eagle's.*

The U-2 was basically a glider with a jet engine. Its 80-foot wingspan, nearly twice as long as the fuselage, allowed the U-2 to cruise in the thin upper atmosphere with only intermittent use of the jet engine. Since the engine could be run at idle for long periods, the fuel-efficient U-2 could stay aloft for hours. Its high-resolution cameras, developed by Dr. Edwin Land of Polaroid fame, were accurate enough to spot golf balls on a putting green from an altitude of 55,000 feet.

The first U-2 flew in August 1955, as part of a top-secret Central Intelligence Agency program. Public disclosures of the airplane's existence referred only to its use for high-altitude atmospheric testing, a job the airplane *did* perform on occasion. But by the time of the Powers U-2 incident, word had begun to leak out that the U-2 was more than a research vehicle.

The U-2 on display in the Museum, given number 347 by the CIA, is a historic aircraft. The seventh constructed, it was pieced together virtually by hand at Kelly Johnson's "Skunk Works" in Burbank, California. On July 4, 1956, no. 347 made the first American overflight of the Soviet Union, taking off from Wiesbaden, West Germany, for a long flight that passed over Moscow, Leningrad, and the Baltic coast. The mission so surprised the Soviets that they did not even protest the incursion into their airspace.

Number 347 was also one of the first to photograph Soviet missiles in Cuba in 1962, leading to the tense Cuban Missile Crisis. Originally assigned to the CIA, this airplane flew out of bases in England (without its coat of black paint, in order to lessen its sinister appearance), West Germany, Cyprus, and Edwards Air Force Base in California. In 1969 the CIA loaned no. 347 to the Air Force for use in Southeast Asia, and it officially became an Air Force airplane in 1974. Number 347 remained operational until 1978, when the 22-year-old spy plane finally came in from the cold.

The U-2 was presented to the Museum in August 1982. "At that time we had no firm plans to exhibit it, but it was an important aircraft for the collection," says Don Lopez, deputy director for the Museum. "We later decided to do the 'Looking at Earth' gallery, and it fit the theme exactly, though it was marginal to get it inside." A hole had to be cut in the roof of Gallery 110 to accommodate the large aircraft, which was suspended from the ceiling, banking in a turn to the right.

Despite the awkwardness of the U-2—the wings were so long that detachable "pogo sticks" with wheels were sometimes used on the wing tips to keep them from dragging during take-off—the airplane has been in service far longer than anyone believed possible. The U-2 aircraft series, with minor modification, is still in service, though now known as the TR-1 (for "Tactical Reconaissance") because the Air Force wished to eliminate the unpleasant connotations connected with the U-2 name. Today satellites perform much of the U-2's reconnaissance work, and the TR-1 now does

more of the atmospheric research the U-2's original press releases had *them* doing.

## *The Flight of the Vin Fiz*

Early in the morning of September 18, 1911, pioneer aviator Calbraith Perry Rodgers was preparing to depart in his Wright EX biplane *Vin Fiz* for the second day of the first flight across the United States. The first day had been a good one, covering 104 miles from Sheepshead Bay, Long Island, to Middleton, New York. If he improved that pace slightly, Rodgers could conceivably make the coast-to-coast journey in the 30 days required to win a $50,000 prize offered by newspaper publisher William Randolph Hearst.

Chomping down on his ever-present cigar, the daring aviator lifted his fragile aircraft off the ground . . . and flew it straight into a tree.

It was the first of 19 crashes for Rodgers in his historic but disaster-prone transcontinental flight to California, which lasted 49 days, 19 beyond the limit set by Hearst. And by the time Rodgers finally waded into the Pacific Ocean, on crutches, he had suffered two broken legs, several cracked ribs, a broken collarbone, and had an arm riddled with fragments from an engine cylinder that exploded in flight.

The poor *Vin Fiz* fared little better. Of the airplane that took off from Long Island in September, only one strut, the rudder, and a drip pan actually made it to California by air. The rest ended up being replaced piecemeal en route after each of Rodger's many crashes. Remarkably, perhaps even miraculously, a bottle of Vin Fiz soda attached to the one surviving strut also made it to California intact.

The little wood, wire, and fabric biplane hanging in the Museum's "Pioneers of Flight" gallery is mute testimony to Rodgers' daring flight of 75 years ago. With only 90 minutes of flight training, a mere 60 hours of flight experience, and an airplane not designed for such a journey, Rodgers was embarking on a hazardous mission. The Wright brothers, who had sold him the *Vin Fiz*, so doubted his chances they loaned him their mechanic.

Rodgers, a six-foot-four ex-football player, was nothing if not stubborn. He had persuaded J. Ogdon Armour of the Armour Food Company that a transcontinental flight would provide invaluable publicity for Armour's new soft drink, Vin Fiz. Armour agreed, and decided to put up the costs for the trip and pay Rodgers $5 for every mile flown. In return, Rodgers painted the Vin Fiz logo on his airplane and the ground support train car that contained his crew and spare parts.

Rodgers made it to Pasadena more or less intact, but crashed on his way to dip the *Vin Fiz* into the Pacific. It took him a month to recuperate from the resulting broken legs, ribs, and collarbone, but Rodgers then gamely made the symbolic dunking.

Five months later he was dead, done in by a seagull that flew into the controls of the airplane he was flying.

This September, to celebrate the 75th anniversary of Rodgers' flight, Jim Lloyd, of Fishkill, New York, plans to recreate the historic journey. Lloyd, wearing vintage-1911 clothing, will follow Rodgers' route closely, in an experimental ultra-light aircraft modified to resemble the *Vin Fiz*. His sponsor, naturally, will be the Armour Food Company.

Lloyd's inspiration for the flight came from a poster, containing a piece of the original *Vin Fiz* fabric, purchased at the Museum. "I was looking at it about a year ago," says Lloyd, "and I thought, 'Gee, it would be neat if someone recreated that flight. . . . It would be even neater if *I* recreated it.' "

Will Lloyd recreate Rodgers' 19 crashes? "There are certain lengths for authenticity I don't want to go," he says with a laugh.

## *Museum Calendar*

Except where noted, no tickets or reservations are required. Call Smithsonian Information at (202)357-2700 for details.

*Summer Concert Series.* Music by U.S. armed services bands on the West Terrace, 12-1 pm. *Country Current*—United States Navy contemporary country and bluegrass, Tuesdays, August 12, 19, 26 and September 2 and 9. *The Commodores*—United States Navy Jazz. Fridays through August and September 5 and 12.

**August 2** Monthly Sky Lecture, 9:30 am. "Cross Quarter Days," Albert Einstein Planetarium. LeRoy Doggett and Gail Cleere, United States Naval Observatory.

**August 7** Resident Associates seminar lecture, 6-7:30 pm. "The General Aviation Collection," Museum Briefing Room. Jay Spenser, Aeronautics Department. Call Smithsonian Resident Associates Program at (202)357-3030 for ticket information.

**August 14** Resident Associates seminar lecture, 6-7:30 pm. "Post-World War II Military Aircraft," Museum Briefing Room. F. Robert van der Linden, Aeronautics Department. Call Smithsonian Resident Associates Program at (202)357-3030 for ticket information.

**September 6** Monthly Sky Lecture, 9:30 am. "Trip Across the Sun: The Transit of Venus Expedition of 1874," Albert Einstein Planetarium. Jan Herman, historian at the Old Naval Observatory.

**September 11** Public Symposium, "Acrobatic Satellites," 9 am-4:30 pm, Albert Einstein Planetarium.

**September 18** General Electric Aviation Lecture, 7:30 pm. Roland Beamont, Battle of Britain Hurricane pilot and the first British pilot to exceed Mach 1 in a British aircraft, Langley Theater.

**September 21-26** "Aircraft Restoration." Garber Facility. Learn the art of aircraft restoration at a five-day program of workshops and demonstrations led by the Museum's craftsmen. Includes a welcoming buffet and farewell dinner. Call Associates Lectures and Seminars Program at (202)357-1350 for cost and reservation information.

Come visit your Museum on a "Washington Anytime" weekend—two nights (double occupancy) for $99. Includes accommodations, some meals, Museum tour, Smithsonian Castle tour, IMAX film. For details, call or write to the Associates Travel Program, Capital Gallery 455, Smithsonian Institution, Washington, D.C. 20560. (202)287-3362.

—*Tom Huntington*

NASM

*Upon reaching California—barely—it was plop, plop* Vin Fiz.

# Space Plane

*"We are going forward with research [on an airplane] that could, by the end of the next decade, take off from Dulles Airport [outside Washington, D.C.] and accelerate up to 25 times the speed of sound, attaining a low Earth orbit or flying to Tokyo within two hours."*
—President Ronald Reagan, State of the Union Message, February 4, 1986.

*Illustrations by Barron Storey*

By Peter Gwynne

The electronic call from your Tokyo office had popped up on the desktop screen at 16:43 Eastern Standard Time, leaving just enough time to pack the needed data cartridges and hightail it to Dulles. At the airport, you follow corridors marked by a new international symbol: a slightly oblong circle—the track of an Earth orbit. You board just at dusk—but with no windows in the cabin, the time of day won't be apparent until after takeoff, when the exterior scene is selectable on the video screen atop your folding tray table.

A tractor pushes the slate-gray aircraft back from the gate, and somewhere deep within the belly of the great beast you can hear—no, feel, really—the huge turbines spin up as the engines whistle through their start cycle. The control tower is holding all other ground traffic and inbound flights; because its fuel consumption has been computed

*Computerized "experts" and advanced displays will help pilots fly at more than a mile per second.*

precisely, nothing must interrupt the fluid motion of the "Orient Express" as it departs. As the space plane turns onto the runway, the dying sunset gleams dully off the heat-stained skin of its fuselage and vertical fins.

From beneath the tail, first a crackle, then an eruption of blue-white flame emerges as the craft begins to roll forward, accelerating rapidly. Then, rotating and standing straight up on a base of fire that resembles nothing so much as a huge electric spark, it thunders almost straight upward. Trans-Atmospheric Spaceflight 17 is on its way. Flight time this evening to Tokyo's Narita Airport: two hours, 18 minutes.

The view from the aft camera shows pinpoints of ground lights that rapidly merge into a vast splash of light that is Washington, D.C., as the space plane climbs, passing through the "sound barrier" that had terrified pilots only 50 years ago. You select "flight data" on the video display, and the wind noise from the air outside passing over the skin gradually diminishes as the altitude read-out changes from feet to miles. Twenty, now 25 miles, and still climbing. You pass through 4,000 miles per hour, still accelerating as the space plane makes the transition from atmospheric to space flight. There'll be no time for a movie. You've caught and passed the sunset over the Pacific, and in half an hour, you'll begin the long descent to a landing in Japan, where people are just leaving home for work.

It may be 20, perhaps 30 years before flights such as this one become routine. But it's been 15 years since Congress killed the supersonic transport—the SST—and 10 years since the Anglo-French Concorde made its first commercial flight, so who's counting? After a long wait, the aerospace industry finally has something truly revolutionary to chew on: a whole new kind of vehicle, one that would go faster, fly higher, and be more ambitious than anything that has flown before. The space plane, otherwise known as the National Aerospace Plane, the hypersonic airplane, the trans-atmospheric vehicle, and the "Orient Express," is on its way. And it will change global transportation dramatically: the vehicle "would probably do to today's jumbo jets and supersonic transports what airplanes did to ocean liners," declares Thomas O. Paine, former administrator of the National Aeronautics and Space Administration (NASA), and recently chairman of the National Commission on Space.

Able to take off from most large civil or military airports, the space plane would use advanced engines capable of speeding it to near rocket speeds and lifting it to the fringes of space. From there, it might continue its ascent into orbit to perform tasks now done by the shuttle, or it could arc back down and land at an airport half a world away from its origin. Its ability to take off from a runway rather than a vertical launch pad makes it different from the shuttle orbiter, and its ability to reach space makes it more capable than any airplane flying today.

In a way, the space plane is the natural successor to the shuttle orbiter, which pioneered the idea of a reusable spacecraft. But the space plane is to the shuttle as a Porsche is to a Mack truck. Where the shuttle is limited to an unpowered gliding return to Earth, space-plane pilots will have engines to power their return and therefore more control

over how and where they land.

Like the shuttle, the space plane could perform military jobs. It could give the United States almost instant access to space, soaring up to launch and retrieve intelligence satellites, lofting heavy cargo into orbit, and carrying out high-altitude reconnaissance. In civilian form, the space plane could launch astronauts and cargos for NASA, or it could be adapted to work as an enormously fast, high-altitude passenger-carrying transport operated by commercial airlines to link North America and Asia—hence, the "Orient Express"—in one great leap across the Pacific Ocean.

Supporters of the space plane say the vehicle will perform its full array of orbital tasks relatively cheaply. One target is to reduce the cost of orbiting payloads to about 10 percent of the shuttle's costs—that is, to less than $200 per pound, and perhaps as little as $20 per pound. Routine, scheduled, airline-style operations are still a matter of contention. But a National Research Council report released last year suggested that today, the United States can develop a hypersonic aircraft that will be competitive with modern subsonic airliners in terms of both capital investment and operating costs. "There's only one tough research and development obstacle," contends George A. Keyworth II, former Science Adviser to President Reagan and major proponent of the project. "Can we learn how to use advanced technologies to make a commercial airplane in the future [priced] so that ordinary people can buy tickets?"

Optimism about the vehicle's usefulness is far from universal. "Who knows what the aerospace plane is good for?" asks John Pike of the Federation of American Scientists. As he sees it, the project in its present embryonic state is geared to different users with different needs, and what begins as a single research project will inevitably branch out into a number of different vehicles, all of them costing huge amounts of money. Several critics of the project suspect that its only realistic objective is to launch "Star Wars" hardware.

Indeed, the research program to start defining the space plane is moving ahead, but as a secret military program under the aegis of the Department of Defense (DoD) and NASA. Overseeing development is the Defense Advanced Research Projects Agency (DARPA), which has already named the program—it's called the National Aerospace Plane, or NASP—and has designated an experimental aircraft—the X-30—to test the concept of a space plane. The estimated price tag for this development phase alone has been pegged at about $2 to $3 billion, which would include money for a few X-30s for flight testing. And the timetable calls for all this to happen rather promptly: "The objective is to have it flying in the early- to mid-1990s so that we have the technology available [in time] for a whole new generation of space vehicles," says Brigadier General Robert R. Rankine, special assistant for science and technology at Air Force headquarters.

The Air Force sent out classified specifications to about 15 aerospace firms last November, requesting bids for work on the engines, a new test facility, and the design for a research aircraft. In April, DARPA announced two sets of initial contracts. General Electric and the Pratt & Whitney division of United Technologies each won contracts that will eventually be worth about $175 million for the advanced engines. And Boeing, General Dynamics, Lockheed, McDonnell Douglas, and Rockwell International each received about $32 million as payments for participating in a competition that will lead to the choice next year of two or three designers for the X-30's airframe. The contracts will run through late 1989, when work should start on actual construction of an X-30.

Whereas bad timing has been blamed for killing the SST, good timing now seems to favor the space plane. All the present activity has been made possible by a concatenation of relevant technologies. Key advances have been made in recent years in propulsion methods, materials, avionics, and computer simulation. "It's a technology mix whose time has come," Rankine says. "We are able to say: 'Look here; all the pieces are coming together; it looks as if a cost-effective combination is possible.' "

Propulsion is the first hurdle, and space-plane engine technology represents a major leap beyond the present-day turbojets. In fact, the space plane will employ three types of engines, each suited to one flight regime, from takeoff to supersonic flight, and finally, to orbital insertion.

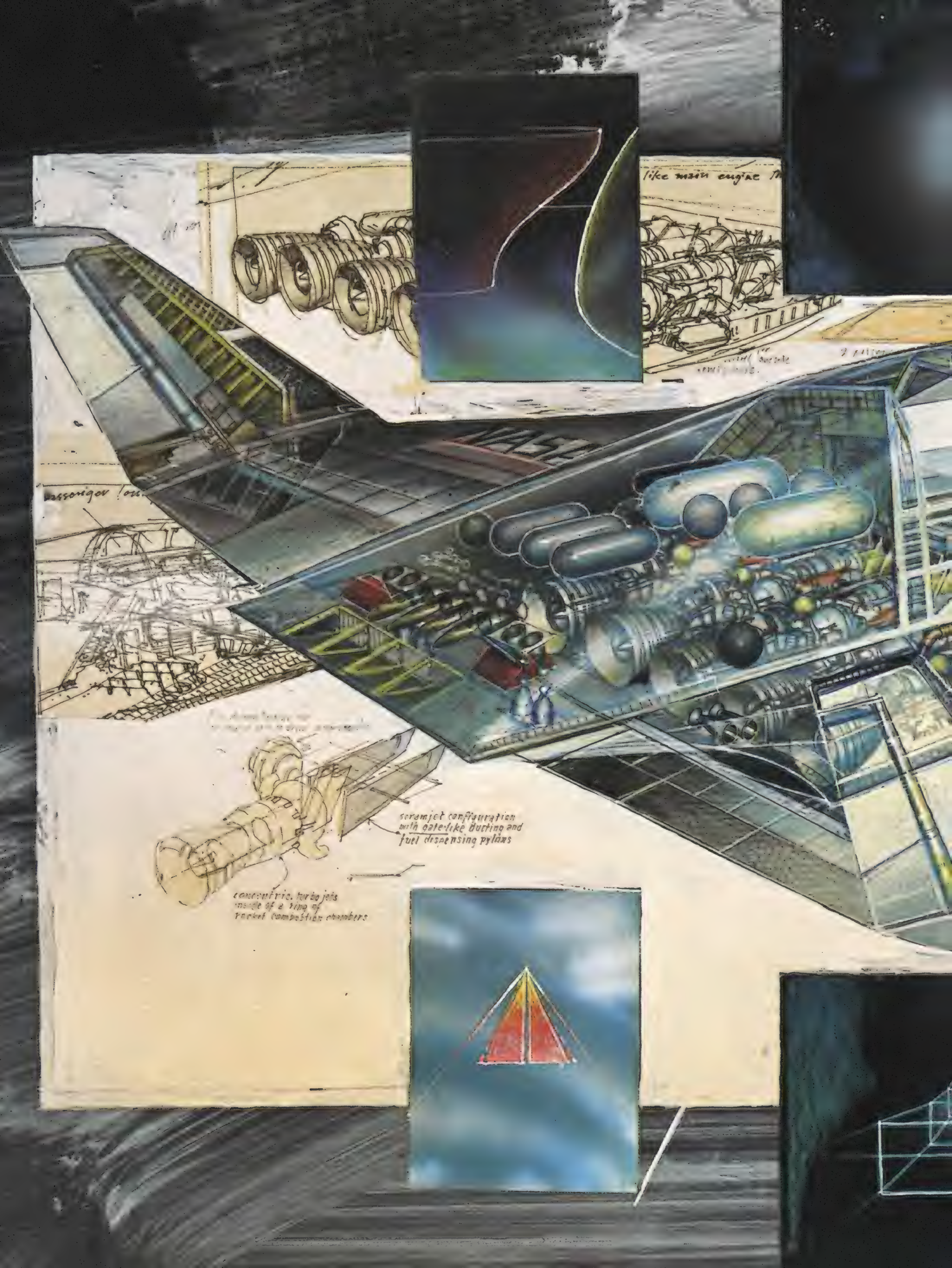
In a conventional turbojet, a compressor increases the density of the air entering the engine. The hydrocarbon fuel is mixed with the compressed air and ignited, which causes it to expand. The expanding gas drives a turbine, which, in turn, powers the compressor before it escapes out the back, thrusting the airplane forward. But as an airplane's speed increases beyond the speed of sound—about 700 mph at sea level—air entering the jet intakes is compressed naturally. By the time the airplane reaches three times the speed of sound—Mach 3—the air is rammed into the engines at a pressure so high that the compressor and turbine are no longer needed. The "ramjet" is a jet engine with neither a compressor nor a turbine, and it's capable of efficient supersonic speed. However, it needs a boost to high speed before it lights up. Hybrid engines—a marriage of turbojet and ramjet—may solve that problem but have an upper limit of Mach 5 or 6. These engines, the most powerful and advanced ever conceived, would still only serve as "first gear."

To push beyond Mach 6, the space plane will need the supersonic combustion ramjet, or "scramjet." It differs from the others by maintaining stable airflow, and hence improved combustion, at supersonic speeds. Scramjets have a long forebody—the region where the ram effect takes place ahead of the ignition chamber. NASA engineers have worked with some success on incorporating this forebody into the shape of the airframe itself.

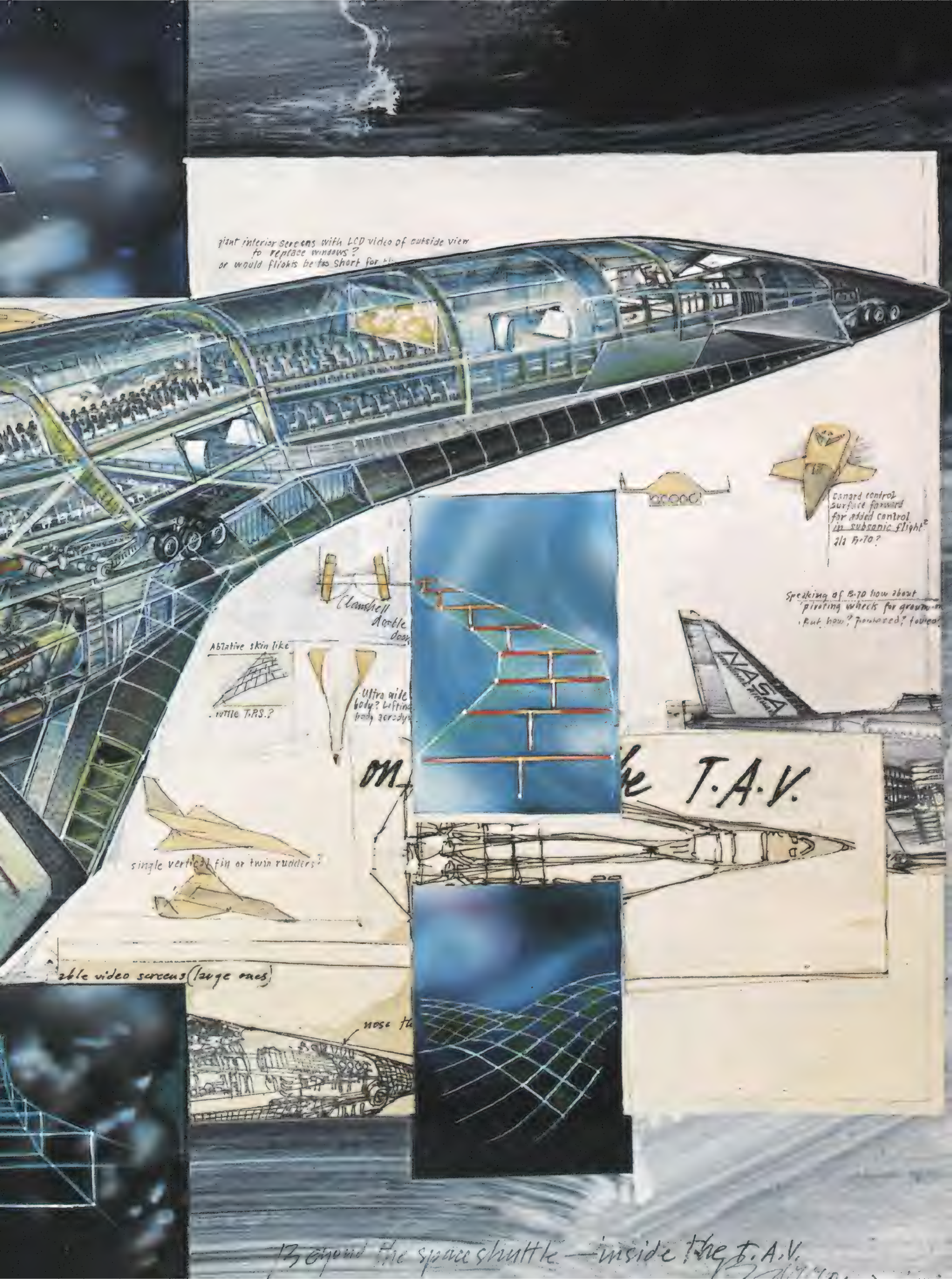
Liquid hydrogen, which burns very quickly, will probably replace conventional kerosene jet fuel. The ultra-cold hydrogen would require insulated fuel tanks and would be injected into the center of the engine, rather than along the sides, so that it heats up rapidly to hasten combustion.

But scramjets won't be able to take the space plane into orbit; some form of rocket will also be needed. Several well-tested rocket engines can be called upon to boost the craft beyond Mach 20.

Of these three types of engines, only one type would run at a time, leaving



like main engine
scramjet configuration with gate-like ducting and fuel dispensing pylons
concentric turbo jets inside of a ring of rocket combustion chambers


giant interior screens with LCD video of outside view
to replace windows?
or would flights be too short for
Canard control
surface forward
for added control
in subsonic flight?
Speaking of B-70 how about
pivoting wheels for ground
Ablative skin like
single vertical fin or twin rudders?
NASA
T.A.V.
able video screens (large ones)
Beyond the space shuttle — inside the T.A.V.

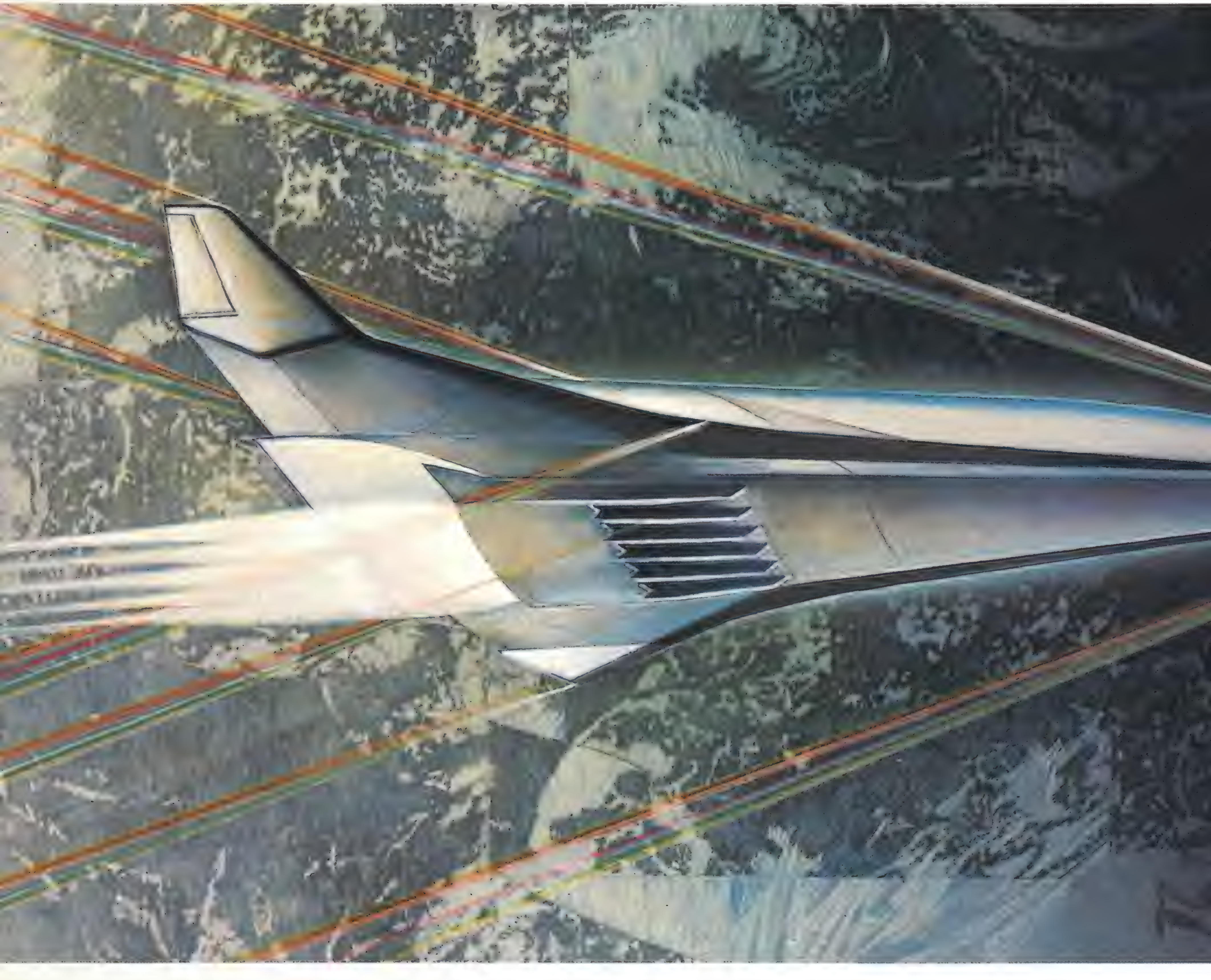
At hypersonic speed, the space plane will compress time and cross between day and night in only two hours.

the two others as dead weight—a problem. NASA has devised one possible solution: a conceptual hybrid engine that combines a scramjet and a turbojet. The two engines are combined in a single capsule and share some features, such as air inlets and exhaust nozzles. And the hybrid reduces—although it does not eliminate—the problem of dead weight, because the components are relatively light.

The space plane's airframe will have to be built of new materials combining great strength with light weight. Any airplane capable of traveling at several times the speed of sound undergoes cruel and unusual punishment. In addition to the heat generated by ultra-fast flight, the airframes of hypersonic craft must also resist the chemical bombardment of highly corrosive individual molecules of atmospheric oxygen.

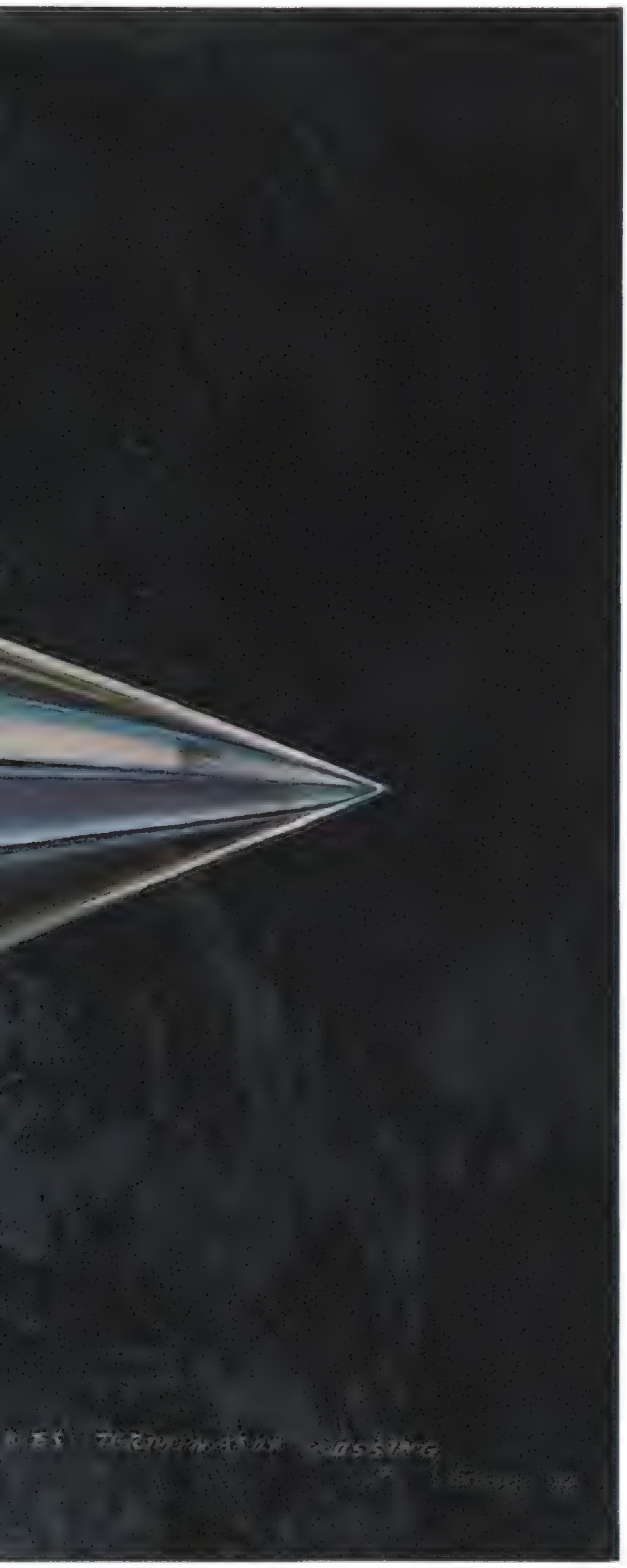
To combat both of these difficulties, aeronautical engineers need a whole new generation of materials. Among the candidates are metals produced by so-called "rapid-solidification-rate" technology. Rapid solidification reduces the size of the metallic crystals, thereby increasing the strength of a metal or alloy in relation to its weight.

Metallurgists obtain this effect by



dropping molten metals onto a cold, circulating wheel, where their temperature drops by thousands of degrees in thousandths of a second. The resulting ribbon of metal is crushed into powder, which can be processed to yield tough metallic parts with about half the weight of aluminum. Other candidates for the airframes include the families of carbon-carbon composites and ceramics.

Just as manufacturing the space plane will require new technologies and skills, flying it at more than one mile per second will be an altogether new experience. Pilots will fly the hypersonic craft through "fly-by-wire" computers that drive the control surfaces electronically instead of by using pulleys and cables. Detailed pictorial displays of the outside world, read-outs on video tubes that replace the clutter of instruments and dials, and computerized "expert systems" to handle normal flight as well as unexpected situations are all under rapid development in the labs. Engineers emphasize that the systems won't take over; rather, the machines will work in concert with humans—in much the same way that copilots work with captains. Artificial intelligence devices will gather measurements from networks of sensors throughout the airplane and suggest specific actions to the pilots.



Equally important, a fresh means for testing the space plane is moving to center stage. Until recently, aeronautical engineers tested their designs in wind tunnels. But even the best wind tunnels can't simulate speeds higher than about Mach 8 for more than milliseconds. However, during the past decade, supercomputers have gradually moved in to substitute for wind tunnels in a range of simulated flight situations. The idea is to use supercomputers to obtain shapes that approximate the actual flight requirements, then to refine those shapes through wind tunnel tests.

The technical advances that have made the space plane feasible in no way guarantee that the program will succeed, though. "There must be no misunderstanding," NASA's deputy associate administrator for aeronautics and space technology Raymond Colladay cautioned Congress last November. "This will be the most complex vehicle ever built."

The environmental effects of space-plane flight will also receive close scrutiny. The Concorde suffered from its engine noise on takeoff and landing as well as its sonic boom. But the space plane is unlikely to encounter public opposition as intense as that which rallied against the Concorde—engineers express confidence that they can keep it almost as quiet as today's subsonic jets and point out that its boom will be less disturbing because the space plane will fly at far higher altitudes.

And the effect of ultra-high flight on passengers is unknown. Will the space plane require protective barriers against high-altitude radiation? "Will passengers have to be qualified for space flight before they can take a trip to Tokyo?" one critic asks.

The major roadblock to the project, though, is certain to be its cost. While the Air Force may justify spending several billion dollars on developing its version of the space plane and acquiring a fleet of them for national security, aerospace companies are understandably leery of betting the store on such a venture. The Concorde offers a cautionary example: it was and remains a beautifully engineered airplane that represented international cooperation at its very best. But it cost too much for the airlines of the time. Only Air France and British Airways bought Concordes, and their governments gave them no choice.

Yet the market may force the United States to develop the "Orient Express." Aerospatiale, the French aerospace firm, has announced "Concorde II." It would carry 200 passengers 5,000 miles at Mach 2.2, use advanced materials, and emit little more noise than subsonic jets on takeoff and landing. The date of its first flight is set for the mid-1990s. Meanwhile, British Aerospace and Rolls-Royce are undertaking a British government study of engines to power the HOTOL, a horizontal-takeoff-and-landing craft that will journey into space. One form of the HOTOL would fly some 60 passengers halfway around the globe in a little more than one hour. Its target date for flight tests is 1996.

Like the space plane, the Concorde II and the HOTOL will consume large amounts of development money—about $6 billion in the case of HOTOL. The British have asked their partners in the 11-member European Space Agency to participate, and both Aerospatiale and British Aerospace have indicated their willingness to link up with U.S. firms.

But if they accept the inevitability of a space plane, the American companies will probably prefer to develop their own. Promoters of the space plane argue that the technology can be accelerated to beat the competition into the air. To supporters like George Keyworth, the actual timing is unimportant. "If we're a truly competitive country, we'll see that the trans-atmospheric vehicle will go," he says. "The space plane is highly symbolic. It separates the optimists from the wimps."

# Ghostwriters in the Sky

*Photographs by Chad Slattery*

# For Greg Stinis and his Skytypers, the wild blue yonder is one big billboard awaiting your message.

By Dennis Meredith

Greg Stinis is only moderately happy with this Los Angeles morning sky—a smog-tinged blue dotted with clouds. But of course he always worries more than most aviators about what the sky is like. After all, what director doesn't agonize over his set decoration, and artist over the quality of his canvas?

Stinis and his fellow fliers are about to use that sky as an advertising medium, painting vaporous billboards at an altitude of 10,000 feet, each up to five miles long and as tall as the Empire State Building. Their "paintbrushes" sit jauntily in an arrow-straight line

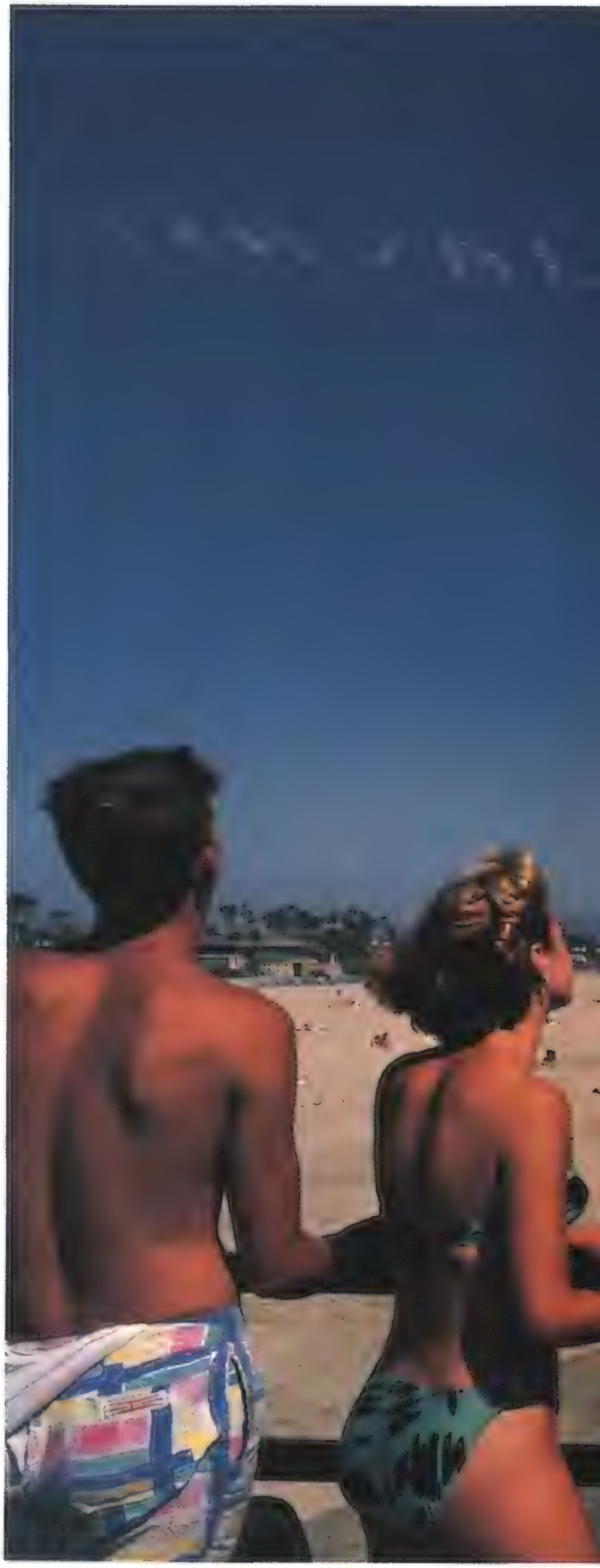
SKYTYPERS

near a runway at Long Beach Airport: five World War II-vintage SNJ-2 trainers, still sturdy as granite almost four decades after rolling off North American Aviation's assembly line. Red, white, and blue stripes and an insignia that proclaims in gold dots the name "Skytypers" have been added to their no-nonsense battleship-gray paint jobs.

After several hours of checking engines, controls, and radios, donning heavy boots and jackets against the colder temperatures at altitude, and strapping on parachutes, the Skytypers are ready. They crank up the 600-horsepower engines, which oblige with a reassuringly throaty roar. Stinis trades thumbs-up signals with the others and the airplanes lumber solidly toward the runway in a weaving conga line, the "S" turns providing better visibility for the pilots.

With Stinis in the lead, they speed down the runway in rapid-fire succession and sail into the air. They rendezvous above the city, each sliding smoothly into place in a tight vee formation, bobbing and weaving slightly in the light wind. Then they climb together to 10,000 feet, where air currents are smooth and won't

*Their aerial paintbrushes at the ready, and with more than 150 years combined flying experience, the Skytypers will soon tootle their messages to the crowds below.*



*Skytypers in mid-stroke (above) salute the 75th anniversary of Navy pilots for California's Huntington Beach Pier crowd (right). This bit of summer reading is only one of many ads created in an afternoon's work.*

disrupt their carefully inscribed prose.

After about 15 minutes, upon Stinis' signal, the airplanes abruptly dip their wings and spread out five abreast in a straight line, 300 feet wing tip-to-wing tip, ready for the day's work. Maintaining the formation is no easy task, but after 15 years of skytyping in the SNJs, the pilots judge horizontal distance by eye and make constant, delicate adjustments to maintain spacing and alignment.

First, Stinis tests the vapor system: if a single airplane mis-squirts, an L could look like an I or a C—or, the embarrassed squadron could invent entirely new hieroglyphs for their immense audience below to snicker at. Each aircraft releases a preliminary puff, a billowing dash of vapor that swirls a bit and then settles into a calm little cloud. The vapor is produced when a substance—Stinis will only say that it's nontoxic and biodegradable—is injected from a 50-gallon tank into the airplane's exhaust. The substance disperses in the exhaust heat, but condenses when it hits the colder air into a thick, white vapor that lasts for two to four minutes before evaporating.

Satisfied, Stinis begins the day's first moneymaking run. He turns on a device in his cockpit that reads a pre-punched tape of messages. As each hole in the tape passes over a sensor, the device electronically signals the appropriate aircraft to release a puff of vapor. As the airplanes speed across the sky at 150 mph, they tootle out their message like an aerial player piano.

They finish the first message in about a minute but can't admire their work: at altitude,

the letters are only indecipherable collections of cloudlets. But below, 80,000 people attending the Long Beach Grand Prix witness the call letters of a local television station appearing almost magically—the airplanes are a line of all-but-invisible dots.

For the next four hours, the Skytypers roar across the southern California sky, "laying out signs," as they say in the trade, for all outdoors to see. With an average workload like today's, they will lay out 20 or so signs, with costs ranging from $650 for a single message to $460 for purchases of 100 or more signs over a season.

The job is no joy ride. Even on an 80-degree California afternoon the drafts two miles up numb feet, and the cramped cockpits make limbs ache and deaden backsides. At last, Stinis calls his pilots back into formation, and they bank out over the Pacific, spiraling down for a finale. Zooming low over the *Queen Mary* with the panache of barnstormers, each

*The skill in skytyping is keeping in line and spelling correctly. It takes a minute flying at 150 mph to produce a short message consisting of intermittent puffs.*

airplane emits a long vapor trail, as if to underline the day's words. Then, they head for their home airport, peeling off one by one to make smooth touchdowns on the runway.

The mission has been a piece of cake. For one thing, the Skytypers are the ultimate pros in the cockpit. Today's team boasts a combined experience of well over 150 years, in everything from SR-71 spyplanes to Boeing 747s. Stinis, 45, has been flying since he was 16. Also, although the straight-line formations required for skytyping are not easy, they're nothing compared to the confusing gyrations of sky*writing*. In skywriting, a single airplane spells out a word by laboriously banking back and forth while turning its smoke on and off.

Skywriting demands pilots with both an expert and artistic eye, because instruments are all but useless: their readings lag behind the motion of the aircraft, particularly when turning.

A skywriter himself, Stinis remembers the hairy moments that make him appreciate the simplicity of skytyping: "Once, when the *Queen Mary* first came into port, they hired me to write 'All Hail the Queen.' I got to the last word, and the other pilots started calling me on the radio to congratulate me. All of a sudden, I couldn't remember whether I had done one or two Es, and I finally had to dive down so I could see where I was."

Despite the aerial excitement of skywriting, it's skytyping, patented by Stinis' father Andy

in 1949, that is the group's mainstay. The elder Stinis was one of the country's premier skywriters, flying a 1929 Travel Air D4D, and is still an active pilot though he no longer skywrites. "He was the original Pepsi skywriter, and during the 1930s, he wrote 'Pepsi Cola' all over the country," says Greg Stinis. Pepsi still uses the Travel Air biplane, flown by Suzanne Asbury-Oliver, 27, to skywrite its logo during weekend festivals at the company's plants.

Over the decades, hundreds of corporations have seen their products hawked by the Skytypers in a variety of languages, including Japanese. The products they have praised to high heaven include cars, suntan lotion, beer, snack foods, baseball and football teams, movies, the armed forces, and, naturally, airlines. The Skytypers have also flown public-service missions—for example, mounting an aerial campaign to prevent forest fires, with slogans such as "War on Arson."

And, of course, they've played aerial Cupid to countless sweethearts, with vaporous hearts on Valentine's Day or marriage proposals and love notes. "We particularly like to do marriage proposals," Stinis says. "The couple likes it so much that we usually get their repeat business every anniversary."

The Skytypers have become a bit selective about what jobs they accept, because of the highly public nature of their craft. "We turn down about half the personal requests we get," Stinis says. "They tend to be a bit strange, and we have to make sure we don't get typed as a bunch of flakes."

Whenever he gets an urge to do something weird, Stinis remembers a dramatic lesson in the power of the skytyped word: "We were working in New York City for a local radio station, and had spelled out everything they wanted," he says. "When we landed, someone said, 'We need an ending—why don't you spell out THE END?' So we wrote THE END over the Empire State Building. It caused all sorts of havoc. Everybody thought 'My God, it's a warning!' and that the Russians were attacking or something."

Even careful Skytypers have their fun, though. *Wizard of Oz* fans will appreciate that SURRENDER DOROTHY has appeared across the California sky—an ad for the open-

*The modified exhaust pipe is like the nib of a fountain pen, dispersing the smoky "ink." The ink's formula remains a Skytypers secret (right).*


ing of a stage version of the movie classic, with Stinis and crew typing the wicked witch's warning on cue from the ground.

The technology of skytyping has come a long way since the early days, when the Skytypers had to laboriously rewire the control apparatus for each run. But even the leap to instructions punched out beforehand on paper tape didn't give Stinis enough flexibility, so he is installing a computer in his cockpit that can hold up to 50,000 messages in its memory. The shoebox-sized device can play out messages in any order, and allows in-flight reprogramming and making italic letters. "Now, we'll be able to announce sports scores as they happen," Stinis says. "It will give us a much better sense of immediacy."

However, microelectronics aside, Stinis does not often think small. One of his dreams is to skytype at 40,000 feet using a squadron of Learjets to lay out vapor trails in the stratosphere. The airplanes would operate just below the altitude at which they would create natural contrails, and would produce vapor with a system similar to that on the SNJs. "We could write messages that would be visible for up to 100 miles," he rhapsodizes. "They would last up to an hour, and as the sun set, they would change colors!" Then, the Skytypers would really have The Right Puff.

*Greg Stinis leads the squadron of SNJs in a vee formation over Long Beach, home of the* Queen Mary, *the* Spruce Goose, *and the Skytypers (above).*

By Henry Lansford

Friday, August 2, 1985, was a showery day over the Texas plains, with clouds ranging in size from puffy little fair-weather cumulus to ominous thunderheads. Just before 6:00 p.m., Delta Air Lines Flight 191—a Lockheed L-1011 en route from Fort Lauderdale to Los Angeles—was on its final approach into Dallas/Fort Worth International Airport.

As the airliner broke out of heavy rain, an air traffic controller watching from the control tower saw that it was too low and immediately transmitted the instruction: "Delta, go around." The message was never acknowledged—the crew already knew they were about to crash. The L-1011 hit the ground in a field near the north end of the runway, careened across a road and struck a passing car, then plowed into some tanks and broke apart. Of 163 passengers and crew members aboard, only 29 survived.

Preliminary findings indicate that Delta 191 almost certainly was struck down by a natural phenomenon of astonishing power, yet one that has only recently entered the aviation lexicon: the microburst—a downward gush of cold air beneath a cloud. For aircraft that encounter a microburst during the few critical moments during takeoff or landing, survival can be largely a matter of luck. Now a large-scale, coordinated effort is under way to detect and counter this dreaded wind.

Microbursts are the deadliest form of "wind shear," a term that describes any abrupt change in wind speed and direction. When the microburst's jet of air hits the ground, it blossoms out horizontally in all directions, like water from a hose aimed straight down onto a flat rock. An airplane flying into a microburst first encounters a strong headwind, then a downdraft, and finally, a tailwind that produces a sharp reduction in airspeed (the speed of air moving past the airplane) and hence a sudden loss of lift. The turbofan engines on an airliner produce an awesome amount of thrust, but their power may not be sufficient to accelerate the massive airplane rapidly enough to escape the forces that push it toward the ground.

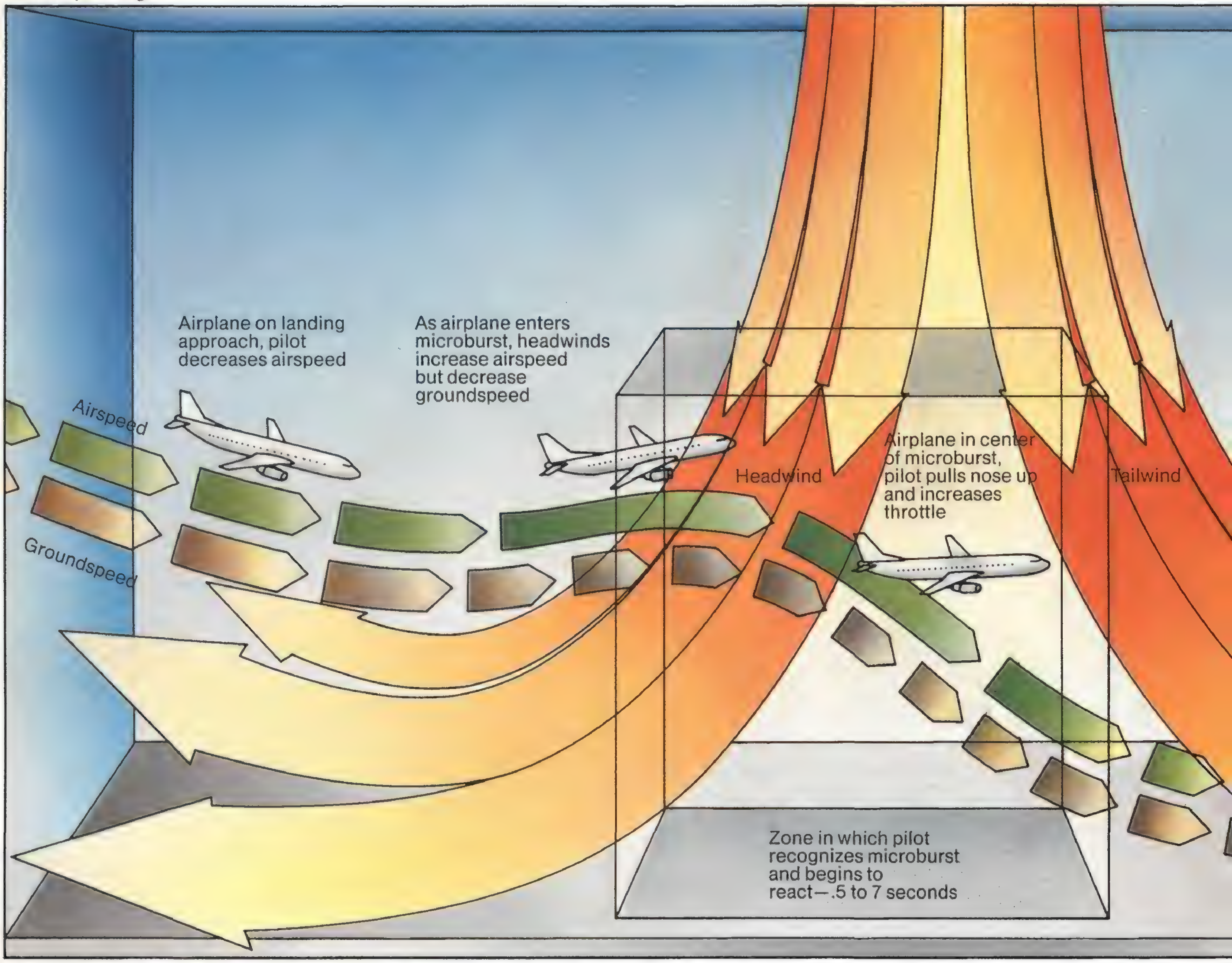
Although the Delta accident drew a great deal of attention to microbursts because it involved a widebody airliner, researchers have now linked them to more than a dozen airline accidents during the last 20 years, including a 1975 crash at New York's Kennedy International Airport that killed 113 people and one at New Orleans in 1982 that took 153 lives.

*American Airlines pilots at their Dallas training center practice in simulators that model the forces in real wind shear.*

# The Might of the Microburst

Scientists probing air crashes discovered an ill wind that can down an airliner. Now the search is on for ways to cope with these incredible downdrafts.

Illustration by Dale Glasgow

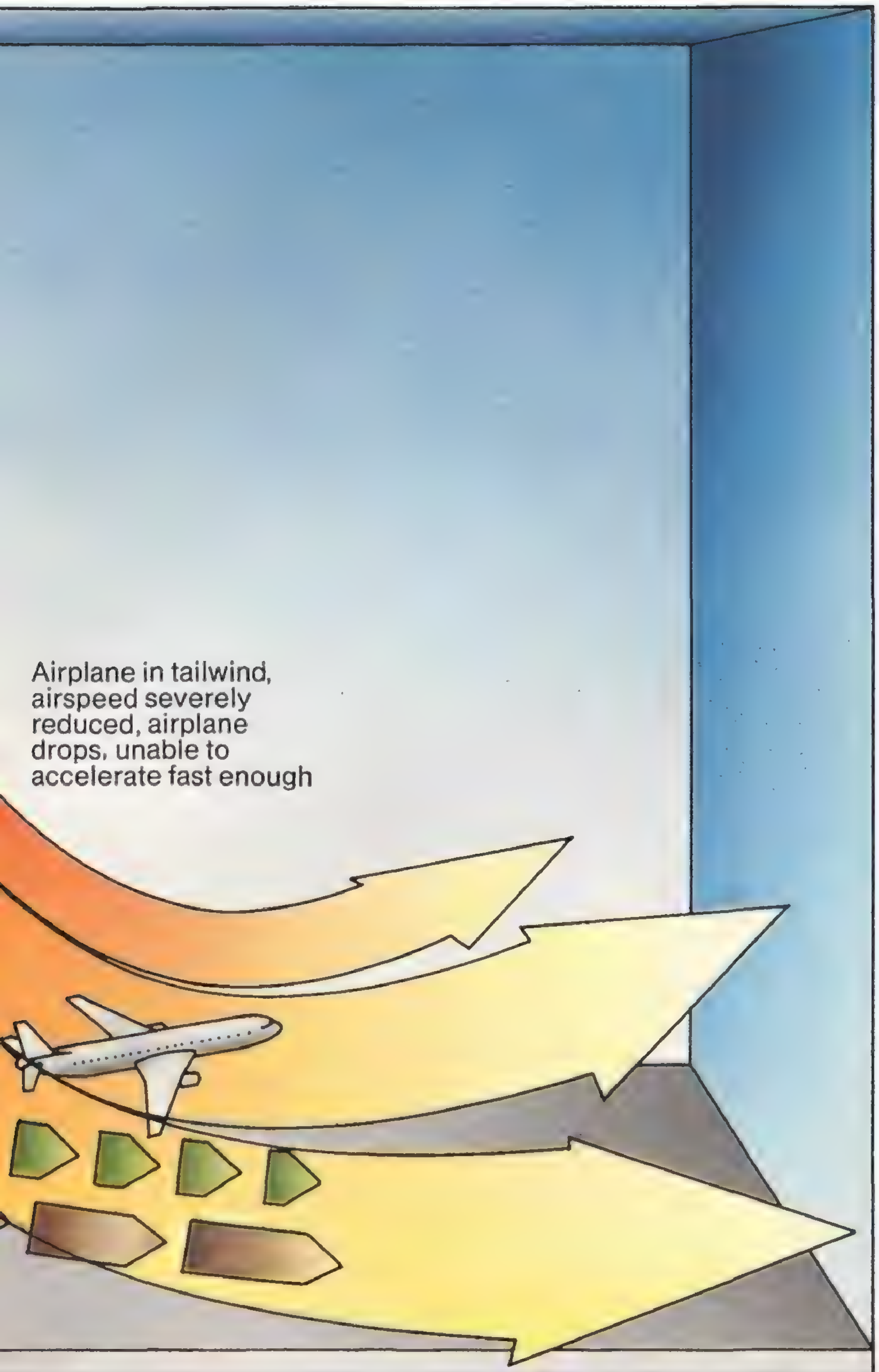



From 1982 to 1985, wind shear—mostly microbursts—accounted for 290, or 65 percent, of the 449 deaths resulting from airline accidents that occurred in the United States, according to the National Transportation Safety Board (NTSB), the federal agency that investigates airplane accidents. John McCarthy, who directs wind-shear research at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, says: "Wind shear is the number-one killer of U.S. airline passengers. It also kills a lot of private pilots, but we don't know how many. They don't carry the flight recorders required on airliners, so we'll never know what happened to some little airplane that went down out there somewhere, except that it crashed and the people died."

The most severe microburst ever observed hit a runway at Andrews Air Force Base, near Washington, D.C., on August 1, 1983, just minutes after Air Force One had landed. The airplane, with Ronald Reagan aboard, barely missed an encounter with the monster. The big Boeing 707 landed at 2:04 p.m. Shortly after 2:10, an anemometer located just north of the runway area recorded a wind from the northwest that peaked at 120 knots—about 138 mph. (A knot, the unit of velocity traditionally used in aviation and marine navigation, is one nautical mile—roughly 1.15 statute miles—per hour.) Then the wind dropped to just two knots and suddenly reversed to the southeast, peaking within minutes at 84 knots. Had Air Force One flown through this microburst, it would have experienced a wind shear of plus 120 knots and minus 84 knots, for a differential of 204 knots—or approximately 235 mph!

While the energy within a microburst can simply overwhelm an airplane unlucky enough to fly into one, perhaps their greatest hazard lies in their surprise. Microbursts are relatively small—by definition less than 2.5 miles in diameter—so they may escape wind-shear detection networks used at many airports. Pilots have learned to avoid tornadoes, thunderstorms, and other dangerous weather. But microbursts, which are most numerous during summer, may pop out of a sky that looks otherwise benign. "The potentially lethal wind shear of a microburst may be packaged in a harmless-looking rain shaft," McCarthy says, "or perhaps in the rain-free air below a cloud base, with no visible cues to warn of its presence."

This combination of small size and virtual invisibility has kept many pilots from taking microbursts seriously as a threat to commercial airliners and other aircraft. "One problem we're fighting is the perception that a pilot with the right stuff can fly through microbursts," says William Melvin, a Delta Air Lines senior captain with 25 years of service. Melvin has had a




### ***How Microbursts Affect Airplanes***

A large jet landing or taking off is both low and slow. It has little potential energy (altitude) or kinetic energy (speed) to spare, and its only source of additional energy is engine thrust. If an airliner is landing in calm air, its speed relative to the ground and its speed with respect to the passing air are about equal. In a microburst, the airplane first encounters a headwind, which momentarily raises its airspeed (air is rushing faster past the wing) and probably causes a slight climb. The pilot might respond by reducing power. The headwind also reduces the airplane's groundspeed, causing a loss of momentum. In the middle of the microburst, the airplane encounters a powerful downdraft and begins to sink. The pilot might raise the nose and climb, probably shedding more speed. When it proceeds into the tailwind portion of the microburst, within seconds the airplane encounters a loss of airspeed (now the air is moving more slowly past the wing) and its wings lose lift. The engines strain to regain the momentum the airplane lost earlier, but since it takes time to accelerate the airplane's large mass, it continues sinking, both airspeed and groundspeed gaining slowly in a race against time. Its situation is akin to that of a person running up a down escalator only to reach the top and step onto another escalator going back down. The shift in momentum is more than the runner can handle and he falls, just as the rapid switch in the wind's direction happens faster than the airplane can react.

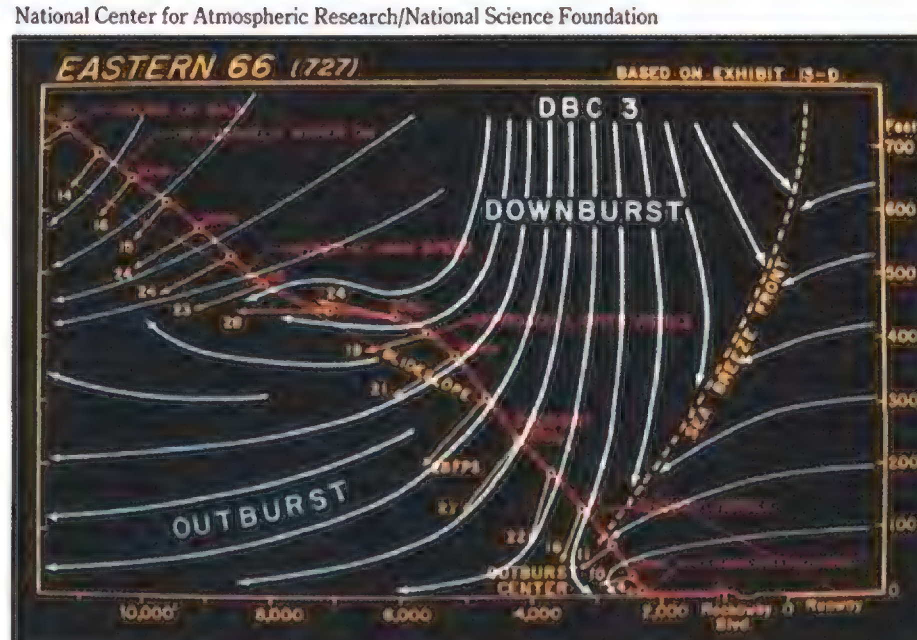
strong interest in wind-shear problems for many years and is now chairman of the Airworthiness and Performance Committee of the Air Line Pilots Association (ALPA). Some of his fellow pilots call him "Wind-shear Willie" behind his back, but they respect his knowledge.

Melvin believes that some crashes involving microbursts were utterly unflyable by anyone, yet have been attributed to pilot error by the NTSB. By blaming pilots, he says, the NTSB has reinforced the attitude that a good pilot with good training in a good airplane can fly through microbursts and survive. "The message we need to be giving pilots is, 'There is something out there that can kill you,' " Melvin says.

William Laynor, deputy director of the NTSB's Bureau of Technology, says: "I think Bill is misinterpreting what the Board said in some of its reports. We have concluded in several cases that the aircraft had the capability to get out of a microburst without hitting the ground, but we didn't intend to say that the pilot was able to accomplish it in each particular situation. There are some microbursts you can't get through, and the key to the problem is avoidance. If you do get into one, it's important to realize that you may have to fly the airplane in a way that you may not be used to."

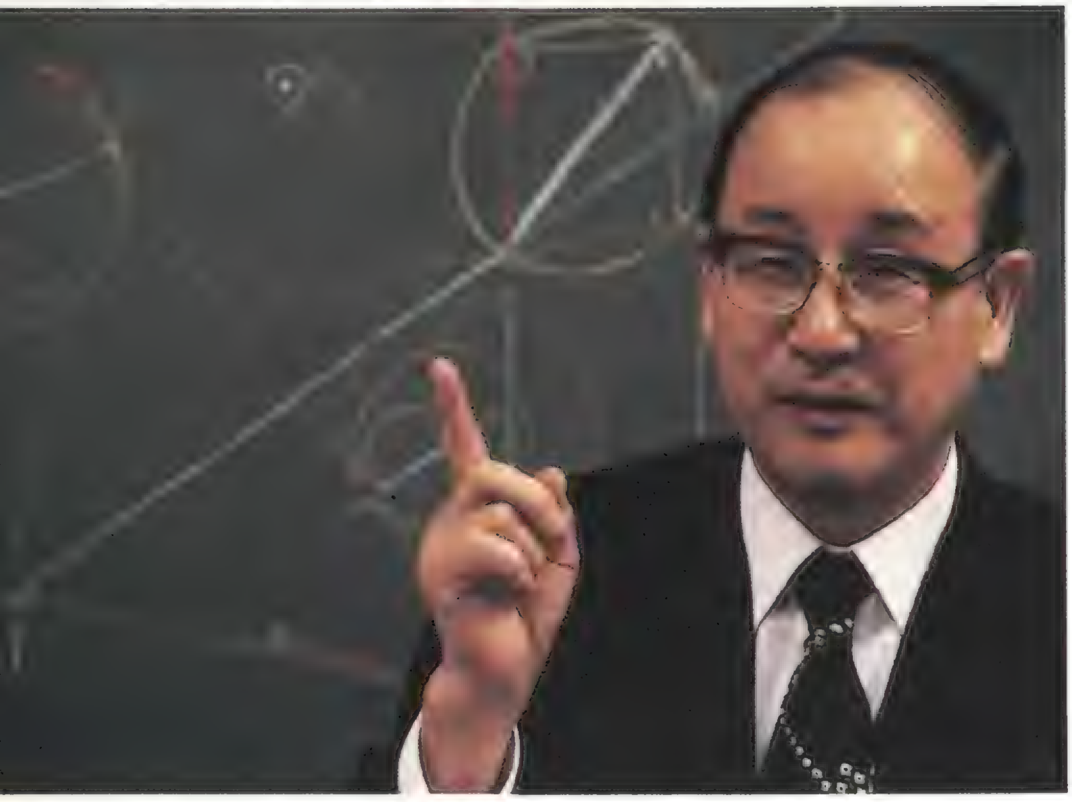
A senior Federal Aviation Administration (FAA) official

National Center for Atmospheric Research/National Science Foundation




*The ill-fated flight path of Eastern 66 at JFK may be the most studied example of a microburst's destructive effects.*

Roger Tully/Discover Magazine Syndication



*The father of microbursts, Tetsuya Fujita helped convince meteorologists and airlines that they are real and deadly.*

shares Melvin's concern about the right-stuff syndrome. "Please don't quote me on this," he says, "but some of the older pilots are a problem. If one of these guys thinks 'I can see the runway, so I'm gonna land this thing,' and he tries to fly through severe wind shear, he's going to die."

That macho, I-can-handle-anything attitude seems to be on the way out, however. At a recent air-safety workshop in Keystone, Colorado, John McDonald, a Delta captain who flies L-1011s out of Atlanta, stood up and stated his position vividly and unequivocally: "When it comes to flying through a bad microburst, there just ain't no damn way." Nobody in the audience—mainly airline pilots—argued with him.

"There are on-board detection systems that alert the pilot that he has encountered wind shear and provide what we call 'escape guidance,' " says James Dzuik, manager of the FAA's weather program. "But in some cases there is no escape—you just run out of air and land short." Cliff Hay, who runs the agency's wind-shear program, agrees: "We feel that maybe ten percent of microbursts are the kind you can't get out of once you get in them. That may be what Delta Flight 191 encountered. As far as microbursts are concerned, our advice is 'avoid, avoid, avoid.' "

The term "microburst" was coined by Tetsuya Theodore Fujita, a University of Chicago scientist whose nickname is "Mr. Tornado." Fujita was investigating an outbreak of tornadoes in 1974 when he found the first clues to the existence of downbursts, which have come to be considered a larger class of powerful downdrafts that includes microbursts. Flying over the twisters' tracks to photograph the devastation, Fujita saw some damage in a wooded area that looked unusual. "Unlike the swirling patterns of fallen trees commonly seen in the wake of tornadoes," he says, "hundreds of trees were blown outward in a starburst pattern." Meteorologists were aware that thunderstorms produce downdrafts, but Fujita's suggestion that the diverging winds from a downdraft could be strong enough to knock down big trees was controversial. "Most meteorologists at that time believed that a downdraft, no matter how strong it may be while it is up inside a cloud or just beneath one, should weaken to an insignificant speed long before reaching the ground," he says.

It took a pair of airliner crashes, one disastrous and the other serious but not fatal, to provide the data for careful analyses that began to establish the downburst as a real meteorological phenomenon as well as a serious hazard to aviation.

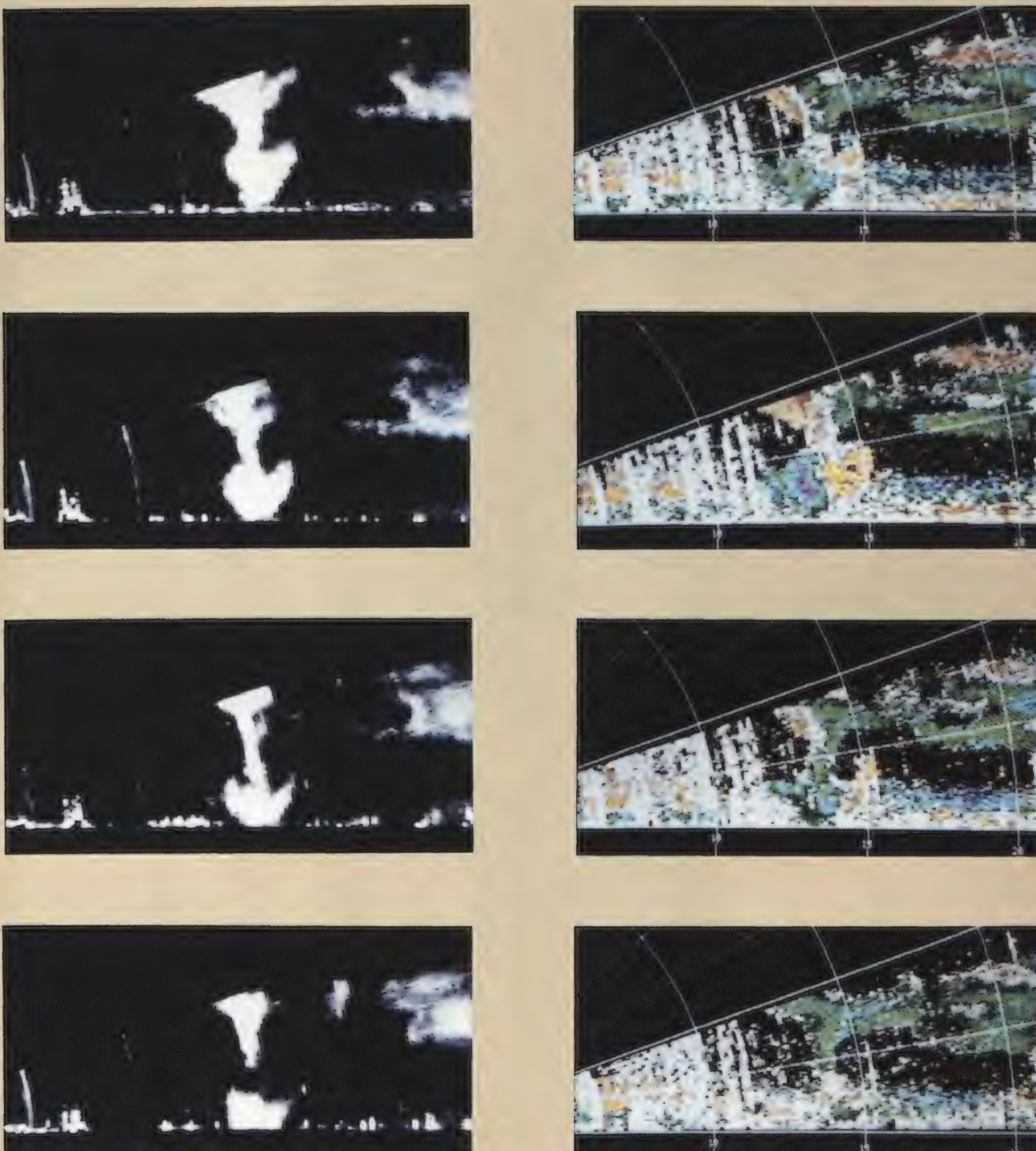
June 24, 1975, was a hot, smoggy day in New York City. By 3:30 p.m., a line of thunderstorms was developing near Kennedy International Airport. Within a 20-minute period ending shortly after four o'clock, ten aircraft landed on Runway 22-L. Next in line was Eastern Air Lines Flight 66, a Boeing 727 inbound from New Orleans. At 500 feet, the airliner encountered rain heavy enough to persuade the crew to switch the windshield wipers to high speed. At 400 feet, they spotted the runway approach lights through the rain. Then the airspeed dropped abruptly from 138 to 123 knots in two and a half seconds, and the airplane started sinking fast. At 4:05, Flight 66 ran out of air. The airplane hit the ground 2,400 feet short of the runway. Only 11 people survived—113 were killed.

About six weeks later, half a continent away, another airliner went down. On August 7, scattered showers roved eastern Colorado. Continental Flight 426, a Boeing 727, started its takeoff from Runway 35L of Denver's Stapleton International Airport at 4:10 p.m. The jet ran into rain as it rolled down the runway, but the liftoff was normal. Without warning, as the airplane climbed out at 150 feet its airspeed dropped from 158 to 116 knots in five seconds. The 727 hit the ground and skidded about 2,000 feet. The passengers and crew were lucky—all 134 survived, and only 15 were injured.

To investigate the crash of Eastern Flight 66, the airline hired Ted Fujita. He began a detailed meteorological analysis of wind measurements, satellite images, radar observations, and flight-recorder data. And to determine why Continental Flight 426 went down, the Air Line Pilots Association requested Fernando Caracena, a physicist with the National Oceanic and Atmospheric Administration in Boulder, Colorado, to analyze the surface winds that occurred in the area that day.

*The most severe microburst ever recorded hit a runway at Andrews Air Force Base just minutes after Air Force One, with President Reagan aboard, had landed.*

***Caught on radar: an electronic snapshot of a microburst.***



National Center for Atmospheric Research/National Science Foundation

*Researchers captured a microburst at Denver's airport on June 12, 1982. Left: radar reflections from water droplets associated with many microbursts. Right: Doppler radar images depict wind velocities inside the same microburst.*

Paul Chesley

*Setting the traps for JAWS: portable weather stations record surface winds that reveal wind shear (left).*

Caracena found ample sources of information. A retired professor who lived near the airport had a private network of three instruments that recorded wind speed and direction. The Army's Rocky Mountain Arsenal, just north of Stapleton, had nine wind recorders, and the state air-pollution control office had measuring instruments around the area. "When I analyzed the wind data for that day and time," he says, "I found a clear pattern of downdraft outflow right across the northern two-thirds of Runway 35L."

Fujita and Caracena joined forces to produce a detailed analysis of the Kennedy and Stapleton accidents, as well as a third crash thought to have been caused by a microburst—an Allegheny DC-9 that went down in Philadelphia on June 23, 1976. Their conclusion: "The most important lesson learned in this study is that no one should attempt to fly through the

*Ground-based Doppler radars search for turbulent winds. Wider use of such systems could save airplanes (below).*

National Center for Atmospheric Research/National Science Foundation

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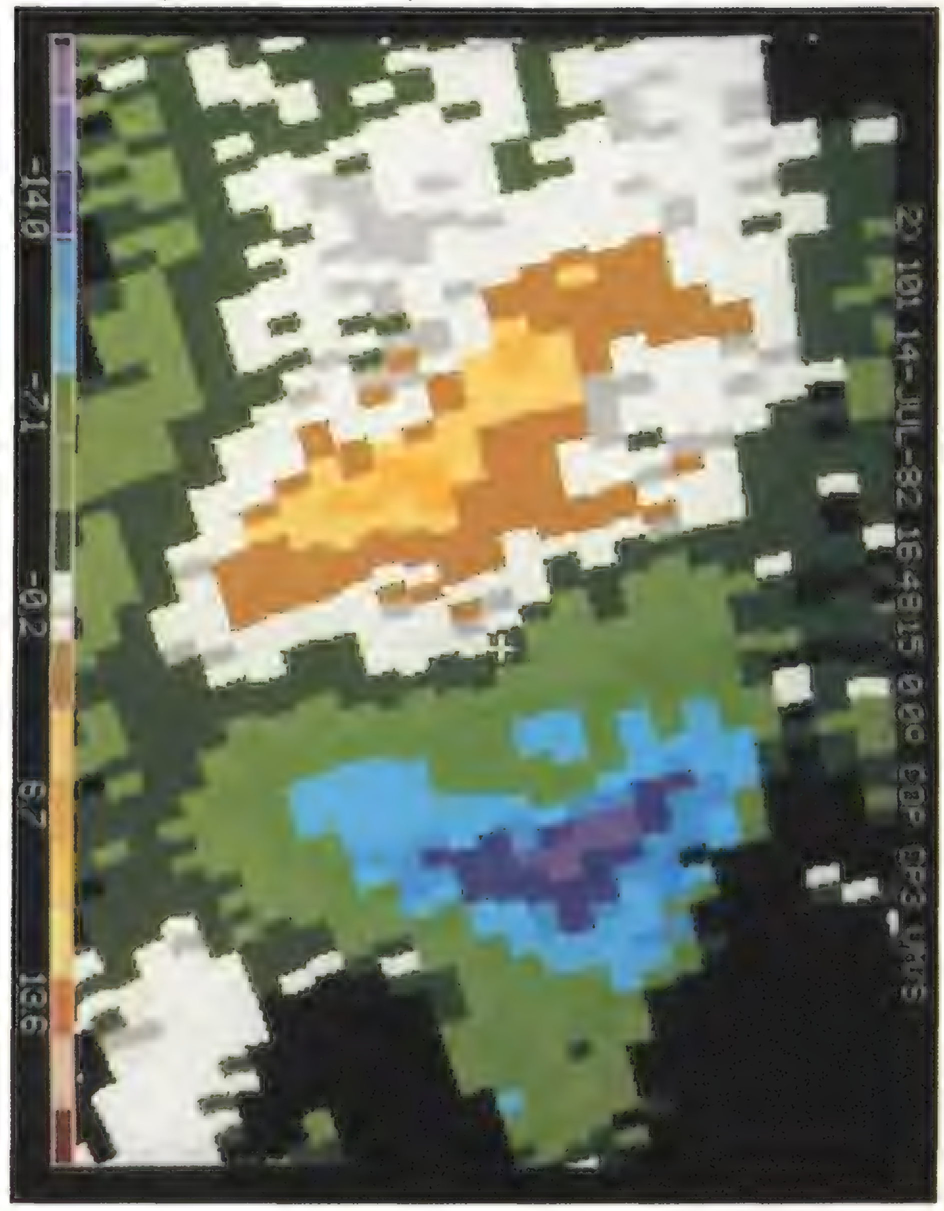


*Air rushes outward in all directions from a microburst's center (cross). Colors reveal speed and direction (above).*

center of a downburst cell."

Gradually, quantitative information on downbursts emerged, mainly from a pair of field experiments conducted in the late 1970s and early '80s. The first was the Northern Illinois Meteorological Research on Downbursts (NIMROD) project. (Meteorologists have an uncontrollable compulsion to give their research projects names that produce catchy acronyms.) Ted Fujita directed NIMROD, and the field work was done southwest of Chicago's O'Hare International Airport in May and June of 1978. The project's goal was to characterize the nature of microbursts as precisely as possible with data from an instrument network, the key element of which was a triangle of Doppler radar installations. Police use a simple form of Doppler radar to catch speeders—it can measure the velocity of a target moving toward or away from its antenna—and a much more sophisticated version has proven invaluable for measuring wind velocity in meteorological research projects. Data from three Doppler radars can be combined to produce detailed three-dimensional maps of the changing structure of thunderstorms and other small-scale weather phenomena. Out of NIMROD came the first detailed look at the airflow within a microburst.

The next major field research effort was the Joint Airport Weather Studies (JAWS), which began in the summer of 1982

John Keating

*A Delta L-1011 crash in Dallas/Fort Worth in 1985 renewed interest in microbursts and triggered calls for more and better detection systems at airports (above).*

as a fairly modest cooperative effort between the University of Chicago and the National Center for Atmospheric Research. The project was designed to obtain more precise data on microbursts than NIMROD had provided, and while it was in progress, another airliner was hammered into the ground. On July 9, 1982, just 20 seconds after Pan American Flight 759 took off from New Orleans International Airport, the airliner crashed in a residential area just east of the airport, killing 153 people. The microburst had struck again.

The Pan American crash made headlines, and public attention was suddenly focused on the microburst hazard as never before. The JAWS study got an unexpected infusion of federal funding and additional research support from other organizations. Working with radar and other instruments in a 615-square-mile area around Denver's Stapleton Airport, the JAWS researchers observed about 160 microbursts in 90 days—an average of nearly two per day. The samples ranged in size from about half a mile to almost two miles across and appeared to last from five to 15 minutes. They intensified during the first five minutes after striking the ground, producing severe wind shear for two to four minutes. The highest differential between the diverging winds was more than 100 mph, with an average of 56 mph.

The JAWS team concluded that a microburst can be triggered when air directly beneath a cloud is cooled by the evaporation of rain or by the melting of hail or snow that can fall from the upper regions of a thunderstorm even on a hot summer day. As the air below the cloud becomes colder and denser than the surrounding air, it starts sinking. The result can be a strong downdraft of cold, dry air. Such "dry microbursts" often occur beneath a veil of virga—rain that falls from the cloud base but evaporates before it reaches the ground. A "wet microburst" is produced when air beneath a cloud is dragged downward by falling precipitation. One frequent clue to the presence of a dry microburst is a ring-shaped cloud of dust stirred up by the diverging air. The presence of a wet microburst is often revealed by a horizontal "foot" of rain carried outward from a vertical rain shaft by the associated downburst winds. Most of the microbursts observed during JAWS were of the dry type that formed beneath virga from dissipating thunderstorms.

The JAWS results proved conclusively that microbursts are numerous, real, and very dangerous to aircraft at low altitude. (NCAR's McCarthy estimates that, during a typical summer, 20 aircraft taking off or landing at Denver could encounter

microbursts at altitudes below 500 feet.) But while the best advice to pilots about wind shear may be to "avoid, avoid, avoid," first you have to know where it is. The only wind-shear detection system currently operating is the Low Level Wind Shear Alert System (LLWAS). It consists of six instruments, each containing indicators that measure the direction and velocity of the wind. One instrument sits at the center of the airfield and the others are located about two miles away in a roughly circular pattern. Every ten seconds, a computer compares the wind at each outlying station to the average readings at the center station. If the difference is greater than 15 knots, the air traffic controllers in the tower are alerted so they can pass the word to pilots.

But there is one drawback: a small microburst can drop into the two-mile gap between the sensor stations and go undetected. The FAA developed LLWAS after the crash of Eastern Flight 66—but before a microburst had been identified as its cause. The agency assumed that the airliner had encountered wind shear produced by a front moving across the airport ahead of a big thunderstorm. Thus, the LLWAS system was designed to detect such "gust-front" wind shear, a phenomenon of far greater size than the downburst.

### *Wind Shear: A Pilot's View*

The best way to handle wind shear is to avoid it. But wind shear can hide in seemingly innocent air—even an ordinary rain shower. And if we were to avoid every little shower, the disruption to schedules would be intolerable.

Pilots want wind-shear-detection equipment aboard their airplanes. Admittedly, these on-board systems can't "see" a wind shear ahead of the airplane. But ground-based systems being installed at a few large airports may not provide effective and timely alerts. So far, at least two fatal wind-shear-related accidents (Delta's at Dallas/Fort Worth and Pan Am's at New Orleans) have occurred at airports with ground-based systems operating. And all airplanes are still vulnerable at airports that don't have the equipment.

Pilots will continue to encounter unanticipated wind shear; it's inevitable. Our main worry centers on relatively rare but very intense microbursts, and our major effort is aimed at surviving the inevitable encounters with them.

Many pilots and some suppliers of cockpit systems are optimistic. All agree that nothing in today's cockpit—or under development for the future—will work until the airplane is already *inside* the microburst, and critics say this may be too late. But there have been accidents involving microbursts that could have been salvaged had there been a more timely warning to the pilot.

Once alerted that he's encountered a severe microburst, the pilot must begin an immediate escape maneuver: as he applies maximum power, he has to maintain a flight path that will keep the airplane aloft as long as possible—and in a changing, often violent, environment. Today's automatic-flight-control systems are designed for much milder control inputs and lack the authority to cope with the extremes a microburst presents. So all the coping is left up to the pilot.

Pilots are taught to claw for altitude. They're supposed to pull back on the control yoke so that the airplane's nose comes up until it's flying "on the stick shaker"—a device used on swept-wing jets to sense impending loss of wing lift and alert the pilot by shaking the control yoke. But the stick shakers have their limitations: they're warning systems, not instruments, and their sensitivity is questionable.

Simulators used to teach pilots this technique may be programmed with less complex—and less dangerous—wind-shear models than the ones nature provides. Flight crews using them may emerge with unjustified confidence in their ability to fly through the danger.

Sperry thinks it may have the answer in an alerting system that measures and compares the airplane's inertial accelerations and its movement through the air mass. The system detects wind shear before the pilot could and provides an alert in the form of lights and voice. It's been demonstrated in some 1,300 simulator tests prior to an in-flight evaluation period aboard Piedmont Airlines' Boeing 737s. And other suppliers are working on the problem: Safe Flight has been marketing a device, and Sundstrand has a system under development.

But pilots are still concerned because all these systems are based on controlling the airplane's nose-up angle instead of its path through the air mass, and they sacrifice airspeed to gain altitude. Angelo Miele of Rice University has been researching the optimum flight path—one that keeps the airplane aloft long enough to escape the downburst—and he has examined thousands of flight profiles. One big problem pilots face is that they don't know the extent of a microburst or where they are within its bounds. Therefore, there's no way for them to know precisely how to manipulate the controls. But Miele's guidance laws could help the pilot come close to a "best-chance" escape pathway. Where earlier solutions concentrated on altitude—getting the airplane *up*—Miele focuses on getting the airplane *out*. It may be less important for the pilot to achieve precisely the optimum path than it is to follow something reasonably close, as long as the warning comes early enough.

Much more research is necessary to refine the definition of the best flight path. Ideally, future instruments will combine the important data in a display that can be read quickly—time is critically important. But none of us can afford to delay the day when the best route out of the wind-shear situation becomes available to a pilot, especially in light of our knowledge that the day when we can "see" one is still a long way off.

*—Thomas Foxworth*

Still, LLWAS networks are in place at 80 airports nationwide, and they are better than no warning at all. Starting last year at Denver and New Orleans, the FAA began upgrading these systems. More stations are being added, and the system's algorithm—the mathematical instructions that allow the computer to make sense of the data that individual instruments are gathering—is being adapted to detect diverging outflow instead of only a gust-front line. McCarthy, who worked closely with the FAA on the LLWAS upgrading, says the system should be in place at 110 airports in the United States by 1987 or '88. But the LLWAS alone is not enough.

"In one minute, LLWAS makes 100 surface-wind measurements around the airport," McCarthy says. "Doppler radar can make 500,000 measurements a minute at altitudes up to 30,000 feet over a much bigger area." Doppler radar can also detect microbursts—that fact has been conclusively demonstrated. Because of its characteristic flow pattern of air diverging radially from the point of impact, the microburst has an unmistakable Doppler signature—adjacent areas of high wind velocity, one with wind flowing toward the radar and the other with wind flowing away from it. A Doppler radar at every major air terminal would go a long way toward reducing the microburst hazard.

The quickest and most practical way to get Doppler radar in place near major airport terminals is to modify a new type of Doppler system that the FAA, National Weather Service, and the Air Force have been developing for years to monitor weather conditions over very large areas. The same computers, antennas, and other hardware needed for NEXRAD ("next-generation radar") can, with a few technical modifications, be used to detect small-scale features such as microbursts. Funded by the FAA, researchers at the Massachusetts Institute of Technology's Lincoln Laboratories are developing the necessary algorithms that will recognize a microburst's telltale signature in the enormous amount of data that the new radars will collect. And this summer they field-tested a prototype detection system in Huntsville, Alabama, in conjunction with two projects: Fujita's Microburst and Severe Storm (MIST) experiment, and the National Aeronautics and Space Administration's Satellite Precipitation and Cloud Experiment (SPACE).

While researchers are still at work, however, the fundamental efficacy of an operational wind-shear detection and warning system based on Doppler radar was demonstrated in a 1984 project called CLAWS (for Classify, Locate, and Avoid Wind Shear). Like the expansion of JAWS after the New Orleans crash, CLAWS was an exercise in what McCarthy calls "tombstone technology. It often looks as if people have to be killed to get the system moving."

*The Federal Aviation Administration is anxious to get improved microburst-detection radar systems in major U.S. airports, but the issue has become a political football.*

*Boeing 737s now in production will soon enter service equipped with wind-shear-detection and pilot-alerting systems for routine flight operations (right).*

The incident that stimulated CLAWS did not require any tombstones, but it came close. On May 31, 1984, United Airlines Flight 663 took off from Stapleton while several indicators pointed to a microburst in progress. A commuter turboprop that had just taken off reported a 20-knot loss in airspeed on climbout, virga and blowing dust were visible, and the LLWAS system had triggered an alert. When it was just about to lift off the runway, Flight 663 suddenly lost about 20 knots of airspeed. John Perkins, a pilot who was filling in as flight engineer, had been trained in a new technique for getting through wind shear, and he quickly advised the pilot, Arthur G. Gore, to trade off some airspeed in order to gain some altitude by hauling back on the control yoke to get the nose of the airplane up. Fortunately, Captain Gore was able to coax the airplane into the air before he ran out of runway. It looked as if the right stuff had come through—a good crew with good training in a good airplane had beaten a microburst.

But as the airplane climbed away from Denver, the crew noticed that the cabin was not pressurizing normally and returned to the gate at Stapleton. When the airline's ramp crews gathered to gape at the airplane's tail, the copilot walked back to see what was going on. In minutes, he was back. "I think we've found the pressurization problem," he said. A large gash had been torn in the fuselage when the airplane, during its struggle to gain altitude, had struck a 13-foot-tall navigation antenna located 1,074 feet beyond the end of the runway.

A National Center for Atmospheric Research team was working with Doppler radar in the vicinity of Stapleton at the time, and their data confirmed that Flight 663 had indeed encountered a microburst. The FAA asked the center to conduct a real-time microburst forecast and warning service at Stapleton Airport during the remainder of the 1984 microburst season. The result was the CLAWS project. According to McCarthy, "CLAWS was planned, funded, and implemented in about seven days, something of a record for a project of this type."

The researchers used a Doppler radar located about 18 miles northwest of the airport. The Stapleton air traffic controllers worked closely with two meteorologists at the radar site and two in the control tower. During six weeks in July and August, they issued 30 microburst advisories and five warnings of *lines* of microbursts! Pilots were asked to fill out questionnaires designed to help the scientists evaluate the usefulness of their advisories. One pilot noted that the microburst advisory he received was accurate and timely, then went on to say: "By just having this available—note we were a heavily loaded [Boeing] 737 in the critical approach [to landing] phase—this warning in advance may have just saved an aircraft from being forced into the ground short of the runway."

Without such advisories, some airliners will almost certainly continue to fly into microbursts. Pilots are being trained to cope, but not everyone agrees about its effectiveness. Bill


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Melvin, for one, is convinced that the pilot doesn't actually beat the microburst; the best he can hope for is luck—enough luck to get out before the microburst wins.

"United's training is good," Melvin says. "It allowed the pilot [of Flight 663] to stay airborne until he hit the airspeed spike. But the spike is what saved him. If it had come three seconds later, it would have been another disaster." The airspeed "spike" is the point at which the aircraft flies out of the tailwind portion of the microburst and, in a second or two, picks up 25 to 30 knots of airspeed. Melvin calls this abrupt transition a spike because that's what it looks like on a graph of airspeed versus time. "When the aircraft hits the spike, it goes up like a rocket," Melvin says. "That saved United 663."

Captain David Simmon played a key role in developing United's wind-shear training while serving as the airline's Boeing 727 fleet manager. He concurs with Melvin's views on avoiding microbursts. "We have found it is essential to train our crews in wind-shear recognition and avoidance as well as recovery techniques for an inadvertent encounter," Simmon says. At United's training center in Denver, wind shear is programmed into the flight simulators. Indicators of microbursts may be included in the description of "weather" conditions included in briefings that the instructors give trainees prior to the simulated takeoff. The instructor may say that virga and blowing dust are present and an aircraft that just took off reported a 20-knot airspeed loss. If the trainee decides to take off instead of waiting for conditions to improve, his performance is rated unsatisfactory.

Flight simulator training provided by United and other airlines also includes wind-shear encounters based on flight-recorder data from actual incidents, including fatal ones. However, Melvin says that when simulated wind-shear encounters consistently result in crashes no matter what actions the pilot takes, some airlines will "crank down" the simulated weather to make the encounter survivable; some airlines' training philosophy avoids emphasizing bad experiences, called "negative training." But Melvin fears that the result is likely to be overconfident pilots who believe they can outfly microbursts. He says that pilots with different airlines have gotten different impressions of the seriousness of the microburst hazard from their training, and some pilots with smaller airlines may have had no wind-shear training at all.

While Simmon and other United pilots and instructors were developing their wind-shear training programs, he says, "We concluded that differences of opinion within the industry were impeding development of an agreed-upon approach to wind-shear training and that an authoritative training aid was needed to provide a consensus and a common basis for understanding." McCarthy puts it even more strongly. "Many pilots have heard of microbursts and know they are a bad deal," he maintains, "but they don't understand the relationship between the reality of the phenomenon and what it can do to the flight of the airplane. The great majority of pilots in this country do not know what to do when they fly into a microburst."

*For aircraft that encounter a microburst during the few critical moments during takeoff and landing, survival can be largely a matter of luck.*

The FAA has now contracted a consortium of organizations to produce a standardized training program for the airlines. Boeing is leading the effort, which also includes Lockheed and McDonnell-Douglas as well as United Air Lines and a consulting group headed by McCarthy. The plan is to incorporate the latest scientific information about wind shear into a program with heavy emphasis on simulator training.

Because of the consensus that it is better to detect and avoid microbursts than to try to fly through them regardless of how well a pilot is trained, the FAA is also anxious to get terminal Doppler radar at major U.S. airports. However, this effort has become a political football. Last year, the agency proposed installing the radar at 110 airports at a cost of about $3 million per airport. But the White House Office of Management and Budget (OMB) proposed a 1987 budget that would fund radars at only 15 airports.

This has provoked some backlash from Congress and other quarters. Critics charge that the Reagan administration is hanging onto money that is available for terminal Doppler in an effort to make the federal budget situation look better. They also accuse OMB of dragging its feet on development of the NEXRAD system that will be the basis of the terminal Doppler radar. Congressman Norman Mineta, a Democrat from California, is chairman of a House subcommittee on aviation. He says: "We would have acquired NEXRAD in 1986, except OMB said 'Hold it. Look for some off-the-shelf technology that might be cheaper.' We knew from the beginning that was a ploy to slow the program down so they wouldn't have to commit funds. The reason the NEXRAD program came about in the first place was because there was no technology available that would do the job."

Some people who fly the airlines a lot are also getting upset. "True enough, it would cost $3 million per airport to put Doppler into operation, this at a time when Congress is under pressure to cut back across the board on government spending," says aviation editor David Martindale in a recent issue of *Frequent Flyer* magazine. "But the fact is, the money already exists to pay for such an improvement: some $7 billion, collected mainly from an eight-percent airline ticket tax, sits idle in the Aviation Trust Fund. By not spending the money, even for its intended purpose, the administration makes the federal budget look less out of balance than it really is."

In the end, how fast improved systems find their way into everyday use may depend largely on that time-tested tenet of politics: public opinion. As John McCarthy puts it, "Americans don't like to get killed in large numbers in airplane crashes, and congressmen *really* don't like it—they fly a lot more than most of us. Many more people die in automobile accidents than in airliners, and we still don't have seat-belt laws in every state. We seem to be willing to accept a level of risk when we drive a car that we won't accept when we fly. When Americans buy an airline ticket, they expect to get there alive."

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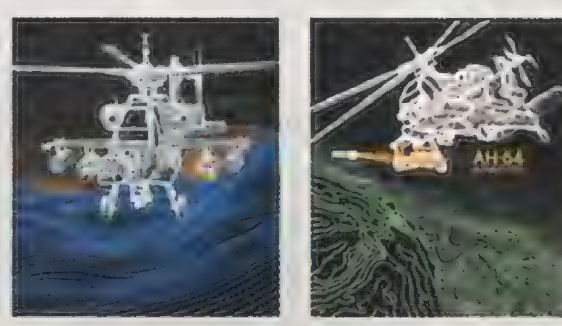
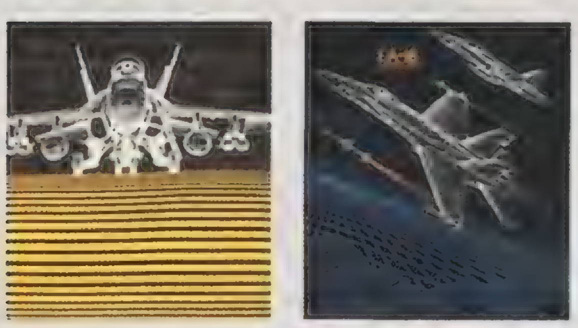


AH-64 APACHE

F-20 TIGERSHARK



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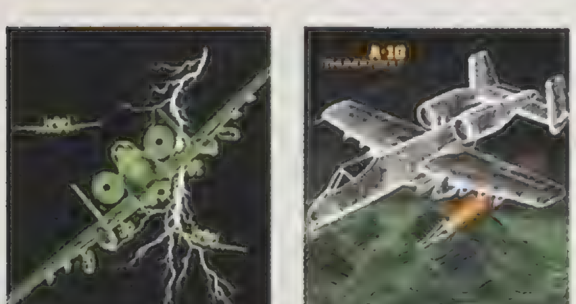
F-4 TACTICAL FIGHTER/BOMBER

F-14 TOMCAT



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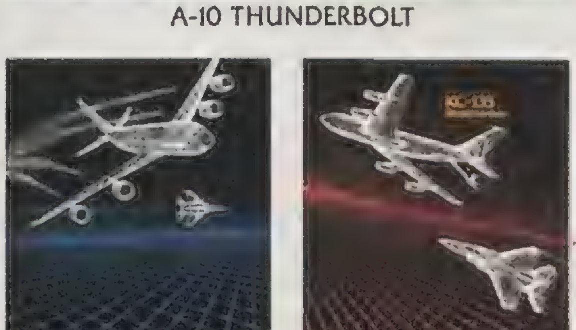
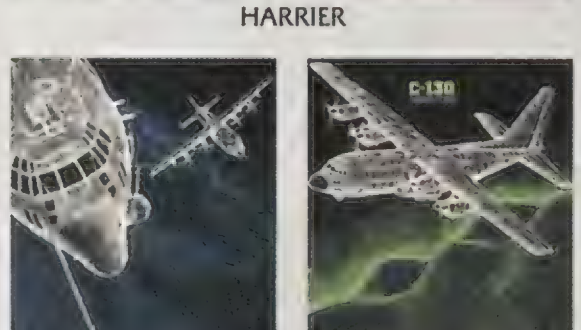
HARRIER

F/FB-111 FIGHTER/BOMBER



KC-135 STRATOTANKER

(actual shirt photos)



C-130 HERCULES

C-141 STARLIFTER

*Essay*

# Rekindling Our Dreams

Congress must monitor NASA more closely and form a top-level agency to set goals for the nation's future in space.

By Ernest Hollings

The National Aeronautics and Space Administration has provided America with the stuff that dreams are made of. With the agency leading the way for more than three decades, we have transcended the bounds of Earth, begun to explore the universe, and placed human footprints on the dusty surface of the moon. In that time, NASA's record of successes led us all to believe that manned space exploration was routine and risk-free. Then, in less than one and a half minutes on January 28, our dreams went up in smoke—*Challenger* had exploded.

In the aftermath of the accident, the government is taking a close look at how the space program is run and how policy is made. The job now facing the president, Congress, and NASA is to determine where our space program went wrong and where it should be heading for the coming decades.

Our space program was born in a time when Soviet triumphs in rocketry and space exploration had focused worldwide attention on America's need to pull itself out of postwar complacency and prepare for the coming age of high technology. We jumped in headfirst, and the space program has now become an integral part of our society, improving communications networks, weather forecasting, military surveillance, and even news reporting. Secondary applications of space technology have enhanced industrial productivity and improved the quality of our lives. Unfortunately, these advances have made the events of January 28 even more devastating. We realize now, as never before, that the United States cannot survive as a strong nation without a vibrant space program. Our failure to remedy problems at NASA quickly, so the agency can again lead the way in space exploration, could well signal the beginning of the end of America's economic and political leadership.

Since the accident, several things have become clear. First, relations between NASA and the public will never be the same. NASA's image has been badly tarnished. This agency, which has given America so much to be proud of, failed on a day when all eyes were on the first teacher in space. The nation lost seven of its best and brightest, as well as a critical launch capability, and NASA lost its reputation as a "can-do" agency that always put safety and technical performance ahead of pricing and scheduling considerations.

Second, space exploration is a risky business. The space program is a research and development effort that requires constant care and feeding. This is especially true for manned space flight, where safety and quality control must be emphasized throughout. The program's many successes were the result of NASA's fixation with detail and strict adherence to exacting operating procedures. NASA deviated from these standards on that fateful day, and the results were catastrophic. Never again can these standards be compromised.

Third, we can't settle for just one type of space-transportation system—the shuttle—with no backup. Access to space is critical to our economic and national security. The United States must maintain a mixed fleet—a combination of manned and unmanned launchers.

Finally, it's now apparent that for too long Congress has neglected its duty to oversee NASA's work, letting the agency become its own worst enemy by nurturing unreasonable expectations in order to maintain a strong base of political and popular support. Good news flowed freely to Capitol Hill; bad news did not. When problems surfaced, NASA was always quick to prescribe a fix and assure us the situation was well in hand. We all wanted to believe in NASA—this was the agency that made the impossible come true—and so we did. NASA was a last vestige of President Kennedy's days of Camelot; the people and the Congress clung to it as something to believe in.

In light of what the *Challenger* investigation has revealed, I now have no doubt that for years we in the Congress failed to ask hard questions about NASA programs and space policy. I fault myself as much as anyone else. Congress and NASA got

too close, rendering the system of checks and balances inoperative. Rather than criticize, we went along with whatever NASA told us, even though we knew agency goals were overly ambitious and objectives were not attainable.

One result of this complacency was a seriously flawed shuttle-pricing policy, announced last year. After 18 months of debate, the president's Senior Interagency Group on Space settled on a policy based on overly optimistic flight rates and unachievable economic returns. These grew from myths fostered by NASA that it would launch 24 missions a year with a four-orbiter fleet and that launch prices would guarantee "full cost recovery." Rather than demanding an explanation for this obviously unrealistic policy, Congress went along. The policy's aim, as it turns out, was not to guarantee that NASA would recover launch costs but to let NASA compete with the French launch company Arianespace. Unsubstantiated goals and assumptions used in forming this policy were "cooked" to fit desired launch and cost targets. These same goals and assumptions may have led to internal pressures that ultimately led to the disastrous final launch of *Challenger.*

If we're lucky, there may be some positive fallout from the *Challenger* explosion that will lead to a safer shuttle program and a more realistic national space policy. For instance, Congress is considering the reestablishment of the National Aeronautics and Space Council as the principal U.S. policymaking body for space matters. The council—established in 1958 and disbanded in 1973—would raise the level of space-policy debate to the Office of the President. The council would have clout if membership were restricted to Cabinet members and top NASA officials who could not delegate their seats to assistants. It could only be effective, however, if the president were truly interested in its work.

In 1958, the public and the Congress recognized the space race as the highest national priority. Now we are reluctant to invest in space, to stay in the race. Sad to say, we are resting on old laurels; if we aren't careful, the U.S. space program could suffer the same fate as the nation's steel and auto industries. While the United States is wavering on how to proceed, the Soviet Union, the European Space Agency, Japan, China, India, and other nations are entering the space race with ardor and resolve. As the Soviets celebrated the twenty-fifth anniversary of Yuri Gagarin's historic space flight on April 12, the twenty-fifth anniversary of astronaut Alan Shepard's flight on May 5 went virtually unnoticed in this country.

Before we lost *Challenger,* our future in space looked bold and daring—manned missions to Mars, a return to the moon, aerospace planes, and advanced shuttles. Now we're focusing on how to put the program back together, not how to move ahead. It's easy to understand why people don't want to talk about future space missions when there's no working transportation system to send them on their way. Everyone's worried about money, too. But budget limits and the roller-coaster cycle of yearly appropriations are inescapable headaches; it might be best to accept them and get to work on revitalizing the space program with the resources we have. We just can't stop dreaming; to stop now could cost the United States its leadership in space.

What shall we do? First, the old NASA philosophy that safety reigns supreme must be revived. Concerns about maintaining a schedule and recovering costs must be relegated to the secondary position they should have occupied before the *Challenger* accident. Second, Congress and other government agencies must continue to pursue allegations of waste, fraud, and abuse as well as poor management and job performance at the space agency and take the necessary remedial actions.

Third, if the choice is between doing a few things well or doing everything with uncertain results, maybe it's time for Congress to defer spending on some NASA projects to ensure adequate support of priority programs. Certainly the shuttle and space station are of top priority—but they should not be our only priorities. NASA is pouring resources into the shuttle and space station at the expense of other worthwhile programs—for example, life sciences, microgravity research, and advanced satellite-communications technology. We should encourage NASA to stop putting all of its eggs in two baskets.

Fourth, we need to get NASA back in the habit of advocating innovative thinking. New ideas, not necessarily new technologies in search of users, should be the order of the day. For instance, NASA's office of aeronautics and space technology, which should be a prime source of support for innovative work, is focusing its launch-technology research on the national aerospace plane; while the aerospace plane is a worthy endeavor, NASA must consider less sophisticated launch technologies that would cut the cost of space transportation.

Finally, we must take a hard look at where the line of demarcation lies between NASA and the Department of Defense, and between governmental and commercial space programs. The subject is worthy of intense congressional debate comparable to the 1958 debate over creating a civilian space agency. Congress and the White House seem more willing to provide money for space-related national security activities than for space science and applications. The Defense Department's space budget is now twice the size of NASA's budget. It's clear the time has come to create a single Cabinet-level agency to oversee civilian and military space activities and maintain a proper balance between the two. If we had such an agency now, we might not need government-wide deliberations over whether and how to buy a replacement orbiter.

The history of NASA and our civilian space program has been one of distinction and accomplishment. I personally have basked in NASA's glory, celebrated NASA's great moments, and shared in its accomplishments. I've listened to astronauts recount heroic feats and heard scientists and engineers describe conquests of new frontiers and amazing discoveries in the world beyond. I stood beside them proudly then, and I must stand beside them now. I hope the American people do not abandon the space program because of revelations about events and decisions that led to the *Challenger* tragedy. We cannot let our fear of the unknown deter our conviction to ponder the imponderable, to dream the impossible. The crew members of the *Challenger's* last mission believed that "a man's reach should far exceed his grasp." And so should we. America must continue to reach for the stars because great nations do great things.

*Ernest Hollings is Senator from South Carolina and the ranking Democrat on the Commerce, Science, and Transportation Committee, which oversees NASA programs.*



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# Star Patrol

## They're out every night, just plain folks, scanning the sky for stars that rhythmically blaze and dim. And astronomers are glad for the help.

By John W. Briggs

From an unpretentious shed in a New England meadow, Gerry Dyck scans the heavens for exploding stars. An evening stroller might mistake the observatory for a hen house, at least until it silently rotates. Inside, bathed in dim candlelight, Dyck's telescope points skyward. He is an amateur astronomer who monitors the outbursts of variable stars—stars that periodically change brightness, blazing and dimming, time after time.

Dyck's 17-inch telescope is homemade, from lumber scraps and a cardboard trash can. Two hundred years ago, when amateur and professional astronomers had much more in common, his instrument would have been at the forefront of technology. But today, research telescopes have grown to gigantic size, and others are literally out-of-this-world: satellites carry them high overhead, where invisible radiation from celestial objects is unaffected by Earth's atmosphere. And soon, hopefully, the space shuttle will thrust the revolutionary Hubble Space Telescope into orbit.

With all this modern equipment in action, it would seem that backyard astronomers couldn't hope to make scientific discoveries. In fact, most amateurs begin with no such ambition: it's rewarding enough just to explore the visual beauty of the night sky. "People go through phases in observing," Dyck says. "First, it's a challenge to find anything. Eventually, you know the constellations and the brighter nebulae. But soon most people set a structured goal."

Dyck's first observing goal was to find all the celestial sights in the Messier catalogue, a list compiled by an eighteenth-century French comet hunter. Messier and his colleagues had noticed over 100 fuzzballs that did not move among the stars as comets should. Through modern telescopes, these objects proved to be the brightest galaxies, star clusters, and nebulae in the sky. It didn't take Dyck long to spot them all. Ready for new challenges, he joined the American Association of Variable Star Observers (AAVSO).

Since its founding 75 years ago this August, the AAVSO has specialized in collecting observations of the brightness of variable stars by amateur astronomers and disseminating the data to the astronomical community. The work can be done with relatively small telescopes, or even just binoculars, so anyone with a little practice can do it.

The distinctive behavior of variable stars is of great interest to astrophysicists, who strive to understand how large, how luminous, and how far away the stars are, along with their birth, their evolution, and their death. The job is not easy. Calculating the birth and death of a star from 75 years or so of data is like divining a life from a page of biography. But astronomers are fortunate that the record-keeping began as early as it did, and that amateur observers have maintained their devotion so enthusiastically. Researchers use the AAVSO records to compare the past behavior of variable stars to theoretical computer models, and they consider the organization's archives an irreplaceable astronomical resource.

"The AAVSO is invaluable to the entire astronomical community," says Michael Bode, of the University of Manchester, in England. "It provides a service unequalled by any other group in the world." His favorite example is a situation when three satellites and several major observatories hoped to make simultaneous observations of the variable star SU Ursae Majoris: "The observatories were clouded out," Bode says, "and the only optical data were obtained by an AAVSO member."

Currently, there are more than 28,000 catalogued variables—far too many for anyone to monitor. The AAVSO's small army, including 474 observers from 34 countries, is able to watch about 2,000. The period, or "cycle time" between outbursts, varies from a few hours to a few decades. And each variable has a characteristic signature, or light curve, that almost suggests personality.

Some stars pulsate, and as they change size, they change brightness. Others have formed in tight pairs, and their orbital motion causes them to regularly eclipse each other as seen from Earth. Some double stars are in such close quarters that they interact physically—matter escapes from one and spirals violently toward the other, releasing tremendous energy that results in an explosion. Such a violent pair is called an "eruptive variable."

While the AAVSO has long experience in working with "conventional" astronomers, the organization entered a new era in 1975 with the flight of the U.S.-Soviet Apollo-Soyuz mission. The spacecraft carried an experiment de-

*A surfer turned stargazer, Richard DuCoty sets his alarm for 2 a.m. to get the best view of the heavens.*

signed to observe celestial objects in extreme-ultraviolet radiation. AAVSO director Janet A. Mattei got a request from the astronomers: "Can your members monitor an eruptive variable while we watch it from space?" The star was SS Cygni, an old friend of AAVSOers. Early members had written poetry about the antics of this curious star, which erupts abruptly every 50 days or so. "Sure!" Mattei replied.

The day the space-based observations began, SS Cygni exploded: its brightness flared by a factor of 40. The sun never rises on the worldwide AAVSO network, so amateurs maintained 24-hour coverage of the star's behavior. Notified of the outburst, astronomers with the National Aeronautics and Space Administration modified the Apollo-Soyuz observation schedule to emphasize SS Cygni. Later, data from the ultraviolet observations were correlated with the amateurs' visible-light observations, providing astronomy with a better understanding of what makes these unusual stars tick.

Success opened the door to other research projects. The AAVSO has now collaborated with NASA's space-based High Energy Astronomical Observatory, the International Ultraviolet Explorer, and the European X-ray Observatory Satellite (Exosat), among others. The organization is consulted frequently when professional astronomers schedule variable star observations using large telescopes and specialized instruments. And requests for its records to compare against theoretical models are more frequent than ever.

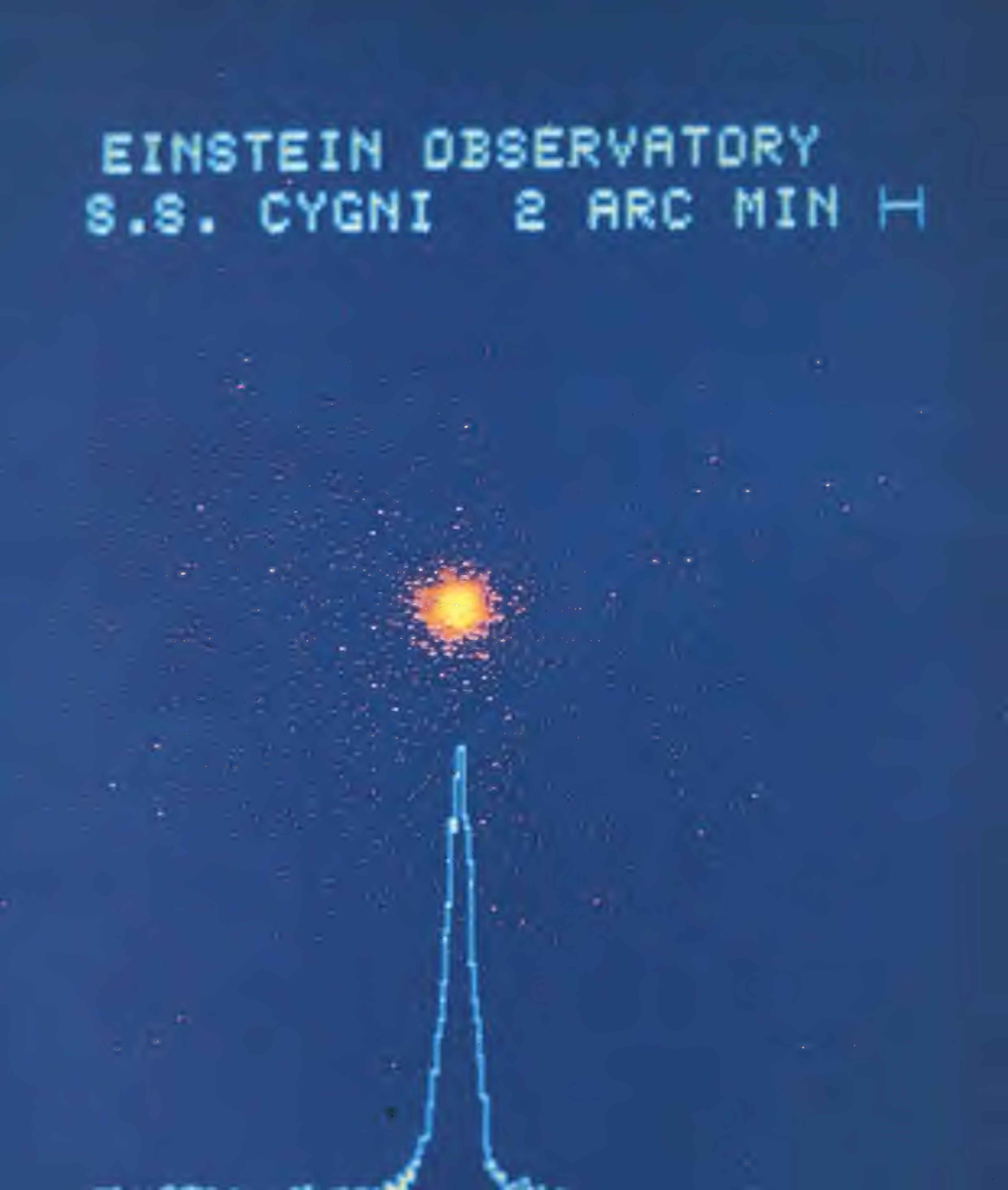
Many AAVSO members were drawn into high-tech astronomy somewhat to their own surprise. Gerry Dyck, for example, teaches music in public schools near his home in Dartmouth, Massachusetts, and is director of a community choral society. In fact, he often combines his passion for astronomy—"it really becomes a compulsion," he says—with his musical background, using a home computer equipped with a program he developed to turn the light curves he records into oriental melodies. "Southeast-Asian music has cyclical features that are analogous to the behavior of variable stars," he explains. He is composing a suite based on variable stars, which will be performed during the association's 75th anniversary membership meeting this August at its headquarters in Cam-

*An orbiting observatory caught this blast of x-rays from SS Cygni, a favorite target of variable star observers, during one of its powerful periodic explosions (right).*

AAVSO

AAVSO

*Styles may have changed, but AAVSO members have remained steadfastly at their telescopes since 1911. Two early members take advantage of Harvard's 15-inch instrument (above), while more gather to compare celestial notes at Yerkes Observatory (left).*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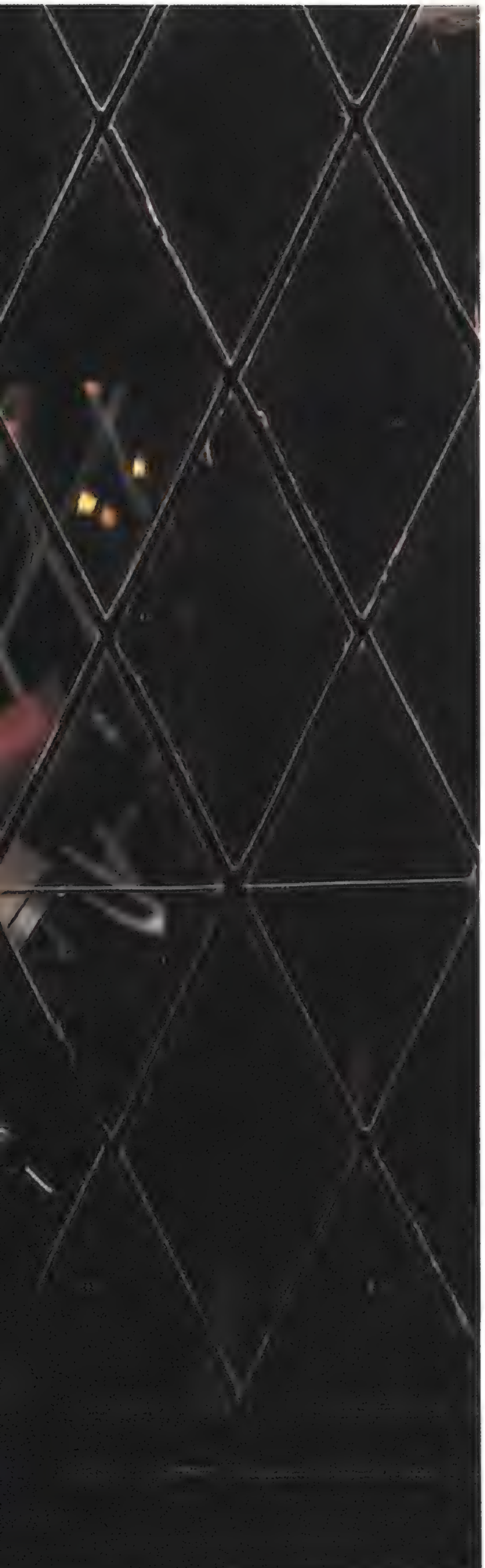
Will and Deni McIntyre

*"It's my main pastime," says AAVSO member Betty McMillan of North Carolina. "It consumes my life."*



bridge, Massachusetts.

In California, Richard DuCoty is an active observer whose teenage interest in astronomy was re-awakened by the 1983 swing-by of a peculiar comet called IRAS-Araki-Alcock. After two years in college during the sixties, DuCoty dropped out. "I went surfing," he laughs. "I became a beach bum." But at the same time, he kept an eye on the sky and familiarized himself with the constellations, which was ideal preparation for work with the AAVSO.

After following the comet's coming and going, DuCoty joined up because he "wanted to make useful observations." The first month he made a few estimates of stellar brightness, working with a telescope on the patio behind his house. Then he made a dozen, and soon a few score. Now, he says, "My goal this year was to make 1,000 observations, but already I'm nearly double that. I'm not spending that much more time at it, but I'm becoming more efficient."

He makes a routine of observing like some people do of jogging. "I go to bed around 8 p.m. and get up at 2 a.m.," he says. "The sky seems darker and things are more peaceful. It's nice." Having returned for his undergraduate degree several years ago, DuCoty will start graduate school in astronomy this fall at Vanderbilt University.

Betty McMillan, a housewife, grandmother, and, according to AAVSO headquarters, "a real Southern lady," observes from her home in North Carolina. Almost every clear evening, she carries her compact eight-inch reflector outside, and often works until about 1 a.m. "It's my main pastime," she says. "It consumes my life. I don't make plans for a dinner party unless it's a full moon and the sky is washed out."

McMillan reports about 800 brightness estimates back to headquarters each year. And she works to get them. "I'm at sea level, with one entire atmosphere overhead getting in the way," she says. "Plus, I have everything of the tropics in the summer and everything of the arctic during the winter."

Sometimes there are other obstacles, too. Last May, McMillan lost 11 nights to the smoke of nearby forest fires. "The fire made the sky look Martian," she says. "I sent a little note to headquarters with my monthly report—'I did the best I could.' I didn't want the director to think I was losing interest."

There's no chance of that. "I love those stars," she says. "I welcome them every year as they come around."

What also comes around for AAVSO are bills. Meeting the increasing demand from professional astronomers for data has taxed the association's small staff and financial resources, which were barely enough to keep pace with

Will and Deni McIntyre

*Paperwork always follows the fun, and McMillan shows off one of the 800 records she makes yearly (right).*

William Hubbell

*Gerry Dyck, proud owner of High Hill Observatory (above), is nearing his 10,000th brightness check . . . so many that he gets the "cloudy night blues" when bad weather keeps him from his homemade telescope (below).*

the projects of yesteryear. But member support has usually prevented the flow of red ink, even in 1952, when Harvard College Observatory, which housed AAVSO headquarters for four decades, tore down the building and forced the organization out on its own.

Indeed, the picture is brighter than ever. This year's annual meeting will celebrate not only the 75th anniversary, but also the donation of a headquarters building by long-time member Clinton B. Ford. Ford first wrote to the AAVSO when he was 14 years old, and received a personal reply encouraging his interest in astronomy. "Clint has become one of our most valued members by contributing to almost all of our activities, and he's made more than 62,000 observations," says director Mattei. "If not for him, our entire history would have been different—and all because we encouraged the interest of a teenager. We get many letters from youngsters, and we never take them for granted."

The new building comes as a great relief to Mattei, who says she lived in fear of fire in the old rented quarters. There, mountains of paper IBM cards, testimony to the staff's effort to computerize the 5.4 million observations on record, had been stacked to the ceiling and were overwhelming the workers. Now there's plenty of elbowroom, and even a proper library for the volumes of astronomical literature that members have donated over the years.

Gerry Dyck stops by occasionally to browse. But if you really want to find him, check that shed with the doormat that says High Hill Observatory. He's often there, and is now approaching his 10,000th brightness observation. "It really becomes a compulsion," he says, not really complaining. "Three or four rainy nights and I get the cloudy night blues. At about eight o'clock, you're phoning friends 60 miles away to see if it's clear and whether you can come over to observe."

William Hubbell

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*Photographs by Patrick Ward*

# God must have meant for man to fly, otherwise He wouldn't have given him Monsignor Horan.

By John F. Henahan

The idea of carving an international airport out of a peat bog in a remote area of western Ireland seemed to many people like the Irish joke to end all Irish jokes, a green elephant, a massive waste of money. But thanks largely to a fighting Irish priest who struggled against a hostile government—and vigorously passed the collection plate—the joke became reality when Connacht (Knock) Regional Airport officially opened on May 30.

It was an inauspicious debut. Wind and rain prevented all but one of the scheduled flights from landing, and locals who had taken a bus to Dublin so they could be flown back into the new airport were diverted to Shannon Airport, 100 miles away. But the weather didn't prevent a crowd of thousands, singing and waving banners and flags, from witnessing the cutting of the ceremonial opening ribbon. A bishop and an archbishop blessed the airstrip. And Monsignor James Horan, the local priest and the man behind this miracle in Connacht province, told the cheering crowds, "This is the happiest day of my life."

Monsignor Horan, a small man with a few strands of reddish hair criss-crossing an otherwise bald head, appears at first to be the quintessential parish priest. After an easy smile, his first words are those of welcome, and the visitor can sense their sincerity. It soon becomes clear, however, that the monsignor is a bustling, no-nonsense go-getter with an iron fist inside his ecclesiastical glove. And as the inspiration, driving force, and most vociferous booster of the airport, he has an overwhelming obsession to make it succeed—for the good of the region and for the good of Knock's Irish National Shrine, which Monsignor Horan has administered for 20 years.

*Just as this airplane is waved in on opening day, western Ireland hopes to wave in a new era of prosperity (above).*

*I'm Monsignor James Horan. Fly me. Five years ago this was a bog. Today it's the second miracle of Connacht (right).*

# Wings and a Prayer

The region can stand the help. In the seventeenth century, British political leader Oliver Cromwell banished Irish landowners to the province by giving them the choice of going "to Hell or Connacht." Even today there are those who suggest the choice was not an easy one. The town of Knock, which provides the parenthesis in the airport's official name, has only about 800 inhabitants. It's located in County Mayo, for centuries one of the poorest, least developed areas of Ireland. Mayo's population of 110,000, decimated by famine during the mid-nineteenth century, is only one-fifth that of Dublin's.

Until very recently, emigration was still the usual outcome of a young person's life there, and marks of the county's depressed and depressing past are not hard to find: scattered around the countryside are the broken-down remnants of stone cottages, their once-yellow thatched roofs rotten and sprouting with weeds and wild flowers. "From an employment point of view, this is a very deprived part of the country," says Monsignor Horan, a natural-born Mayo man. "Half of our people are out of work and the wage scale is about 25 percent less than in the rest of Ireland. We need new industry, but we realized that no industrialist will take the area seriously without an airport to provide easy access."

At the same time, Mayo is one of Ireland's most beautiful counties. The scenery can be breathtaking: craggy mountain peaks, rolling hills with green pastures, sheep and cattle everywhere. Its lakes and rivers, among the cleanest in the world, teem with salmon and other fish, and the coastal waters are ideal for deep-sea fishing. The airport's backers thus saw great potential for attracting tourists from the United Kingdom, Europe, and the United States.

The airport's 8,300-foot landing strip and modest facilities—which make it one of the world's smallest international airports—sit on a windswept plateau in an area known as Barnacuige, or "Top of the Province." Despite its name, the airport isn't actually in Knock, but in the small village of Charlestown about 16 miles away. And while it is called a *regional* airport, Monsignor Horan admits that most people will think of it simply as "Knock Airport" because of its link with Knock shrine, which dates back to August 21, 1879.

On that day 15 residents claimed they saw an apparition of three figures outside the village church. Tradition now identifies the three as Mary, Joseph, and St. John the Evangelist. Tradition also asserts that the ground beneath them remained bone-dry despite a pouring rain. The shrine has become increasingly important to the area, and each year attracts three-quarters of a million pilgrims from around the world seeking cures, favors, or just a spiritual uplift. Pope John Paul II visited the shrine on its centenary in 1979, giving it the church's highest official recognition. A brightly colored sign on a building bidding the Polish Pope an Irish "Cead Mille Failte" (a hundred thousand welcomes) still catches the visitor's eye when entering the town.

The shrine, inside a large glass enclosure on the main street, is on the edge of an expansive plaza. Visitors can peer inside and see the pilgrims attending mass and the marble statues of the figures from the apparition. They can also stop by the shrine's Folk Museum that portrays "the Golden Treasury of Irish Tradition and Life at the time of the apparition," while some couples spend their time in the Marriage Introduction Bureau. Running along the edge of the plaza is a line of faucets labeled "Holy Water," while the main street is lined with souvenir shops, a few bed-and-breakfasts, and an establishment called St. Anne's Bar—surely the only pub in the world named after Christ's grandmother.

With the airport's potential for industry and tourism as verbal ammunition, Monsignor Horan persuaded the government of Prime Minister Charles Haughey to pledge the necessary funds. Work began in 1981, but not everybody was happy. People in other parts of the country, particularly the urban east, carped loudly at what they saw as a scheme for pouring

*Some critics predict that Knock's windswept location will mean bad weather. For opening day, at least, they were right.*

*Charles Haughey, whose governing party provided early support, flew in to welcome guests on opening day (above).*

*Pipers piped and singers sang as Knock celebrated the long-awaited day when "the airport took off" (right).*

hard-earned tax money into a boggy field in the west. And many meteorologists predicted that the region's poor weather would often close down the airport.

The monsignor wasn't listening to the nay-sayers. "I heard all the arguments in those difficult days," he reflects wryly. "I'd usually tell them, 'Suppose you bought a deserted island and you wanted to have it inhabited quickly. Sure, wouldn't the best way to do that be to build an airport?' "

Build he did. Paddy McDonnell was in charge of construction, once the government's transportation minister had turned the first sod. A man whose speech is at once formal and picturesque, McDonnell says simply, "I always felt that it was within the realm of civil engineering to get it done." Getting it done meant scraping 1.1 million cubic meters of peat from the top of a large bog. (Peat, the decayed remnant of County Mayo's long-vanished forests, is used almost universally by the residents of western Ireland to heat their homes.) Workers then excavated a nearby hill for 4.6 million cubic meters of gravel to support the airstrip's paved surface.

But just when it appeared that nothing could block their

progress, forces stronger than civil engineering intervened. In 1984, Ireland was gripped by a severe financial crisis. A new coalition government of the Gael and Labor Parties replaced Haughey's government, and pledged to put the country on a more stable economic path. One of the victims of their economizing was the airport's money, even though the government had already invested nearly 10 million Irish pounds (about $17 million). That was about four million pounds short of the sum needed for completion.

The airport's critics breathed a sigh of relief. But they


*As Monsignor Horan celebrates Mass, angels overhead presage flights of a different sort (top).*

*Holy water flows like . . . well . . . water on Knock's main street. But bring your own containers (above).*

*Knock's Irish National Shrine, where an apparition astonished townspeople, is preserved under glass (left).*


*The practical, spiritual, and marsupial beckon to would-be guests—the townspeople hope for many.*

hadn't counted on the efforts of Monsignor Horan and his associates, who struggled valiantly to keep the airport alive. "Local people contributed help with the paperwork needed to keep the idea of the airport alive, and workmen chipped in enthusiastically with spadework at the airport site," says Jim Ryan, secretary of the airport's board of directors. "Every village for miles around did their bit."

For his part, Monsignor Horan set out to raise the necessary money. His fund-raising campaign covered not only Ireland, but also included two barnstorming tours of U.S. cities with large Irish-American populations. "Your good country has subscribed in no small way," says Paddy McDonnell. "In turn, our own kith and kin have subscribed generously in kind, so much so that the building and the control tower and the landscaping have been made possible by way of donations from the Irish people."

With the success of this go-it-alone decision, people began taking the airport-in-a-bog more seriously. For example, in October 1985, with the airport's buildings still incomplete, a Boeing 707 and two 737s of Aer Lingus carried several hundred visitors to Rome and back again. Forty thousand onlookers were there to wish them well. But one trip does not an airport make, and so far Aer Lingus, Ireland's national airline, hasn't established an official connection with Knock. An airline spokesman admits that the new airport may take business away from its operations in Dublin, Shannon, and Cork, and says only that "we will use the airport whenever we can."

Others think Aer Lingus may be missing the boat. Danny Higgins, a Mayo man who recently piloted jumbo jets for the airline, has formed Celtic Air, which will initially fly between Knock and London. He eventually plans to fly Fokker 27s to Manchester, Birmingham, Leeds, Glasgow, and Dublin. Maurice Buckby of British Airports International, project manager for the airport, predicts that a quarter-million tourists will arrive at Knock Airport, not including the hordes who come to visit the shrine. Indeed, the *Irish Echo,* a U.S. newspaper with a largely Irish-American readership, began running advertisements promoting charter tours from Chicago even before the airport opened, while other companies are booking flights from New York, Boston, and several other cities.

Ireland's Industrial Development Authority (IDA), which has brought more than 850 foreign firms to the country in the last 15 years, also expects Knock Airport to draw new companies to the region. "The airport may be in the middle of nowhere now," says the IDA's Dan Coffey. "But when it takes off, we expect that it won't be in the middle of nowhere anymore." And local companies aren't overlooking new opportunities. For example, Halas Meats, located in nearby Ballyhaunis, regularly ships large quantities of Irish meat products to customers in the Middle East. The company used to truck the meat to Shannon Airport, but switched its commitment to Knock even before the airport was completed.

The townsfolk of Knock also look for an economic upturn when, in the oft-repeated phrase, "the airport takes off." Ted and Mary Curry hope it will bring a steady stream of guests to their recently completed "Knock International Hotel," optimistically named, given its ten rooms. The hotel is neat and modern, with provisions for wheelchairs. It also boasts a large bar with a comfortable peat-fed fire, a restaurant, and a function room in which exhibitions of "boxing and dancing" are sometimes scheduled. "We're giving a service to the pilgrims," says Ted Curry. "You could be sitting in your room and hear the shrine announce that there are confessions or a mass starting in a few minutes."

Mary Curry is one of the airport's most enthusiastic boosters. "I think it's the best thing that's ever happened to western Ireland," she says. "We were always left to last here. But I feel that the airport is going to lift the people, not only in Knock, but throughout the whole area. Best of all, it will create employment and that's what our young people need."

Of course, there are still critics who believe that the airport will have great difficulty paying its way, even if the most enthusiastic projections pan out. Characteristically, Monsignor Horan both agrees and disagrees with that view. "An airport should not be judged solely on an economic basis," he notes. "Most airports in the world are losing money. But an airport can still bring enormous benefits to a region through the development of its industry and tourism. That's been our dream for the airport all along."

Some people may still be laughing at this great Irish joke, but not the people of Knock and its surrounding area. But they—like the Currys, Paddy McDonnell, and especially Monsignor James Horan—may well be smiling.

*Proud owners of the Knock International Hotel, Ted and Mary Curry expect to keep all ten of their rooms booked.*


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Dragsters reach the speed of airplanes, but taking off during a race is disastrous. To gain performance and keep them glued to the track, racers are turning to aerodynamics to ensure that...

# The Cars Won't Fly

By Robert C. Post

*Photographs by Christopher Springmann*


*Ready... set.... An official prepares to conduct a symphony of mechanical fury—the quarter-mile dash.*

No competition race car is faster than an unlimited dragster. It is designed for one purpose: to win a drag race, which matches two cars of approximately equal mechanical fury in a timed sprint down an absolutely straight track from the starting lights to the finish line a quarter-mile away. Cars in this class often boast close to 3,000 horsepower and always weigh less than 2,000 pounds. To drive one is like climbing aboard a bullet.

Championship drag races last just over five seconds, but in that time, the dragster's incredible burst of acceleration will push it to top speeds that are more typical of airplanes than automobiles. And that helps to explain why there are bits and pieces of airplane equipment, as well as insight gained from the science of aerodynamics, built into every dragster.

Unlike other race cars, dragsters are built to go straight ahead, period. "Getting sideways," racers' parlance for what happens when a car veers from its planned arrow-like path, is a driver's nightmare. In fact, only one condition is more frightening: "getting airborne," which occurs when air gets underneath the car and lifts it off the track—literally into the air. Such horrors have forced drag racers to pay close attention to aerodynamics.

*Gary Ormsby's new dragster sports a body sculpted by computer software used for aircraft design.*

The origin of drag racing dates back to southern California in the 1950s. The first dragsters were merely old cars fitted with modern "souped up" engines. Their owners met on weekends at rural airport runways that served as communal racetracks. These vintage hot rods were an exercise in sheer horsepower but otherwise rather unsophisticated. Some raced on California's dry lakes, where they had a mile or more to get up to speed before they were clocked. But the airport runways were much shorter, so a car's ability to accelerate was much more important. Here, paring weight counted for as much as boosting horsepower—a lighter car would accelerate more quickly—and it wasn't long before the drivers began removing parts: hoods, fenders, and seats disappeared, then bodies, radiators, and anything else that didn't contribute directly to producing horsepower. Eventually, there was little left but an engine mounted to the frame and axles—racers called the new beast a "rail." The maximum amount of power bolted to the minimum amount of structure—it was a proposition that any airplane designer would have understood at once.

Getting all that horsepower to the ground has also led car builders to seek ways to improve traction. They began by concentrating as much weight as possible on the rear wheels, which propel the car. The ultimate expression of this trend may have been the "slingshot" dragster, on which the engine was moved back and placed just in front of the rear tires, and the driver's cockpit was extended out behind the wheels.

*The trick to going arrow-straight for a quarter mile is to keep the front wheels pressed to the track. Airflow can help.*

Huge tires called "slicks," with an exceptionally large surface area, further improved the car's grip on the track. Narrowing the rear axle, setting up the front wheels like the casters on a grocery cart, and stretching the wheelbase (the distance between front and rear axles)—all helped the car to steer a straight line under increasingly rapid acceleration as performance improved.

Soon the old car frames gave way to a featherweight, heliarc-welded chassis made of thin-walled chrome-molybdenum alloy tube—the stuff of airplane frames. Indeed, several pioneer chassis makers, such as Woody Gilmore, mastered their craft in southern California's aircraft manufacturing plants.

Speeds moved beyond 200 mph, and drag racers, concerned about safety, went to the aviation well once more. They adapted an assortment of airplane paraphernalia, including parachutes to help slow the car at the end of a run that are similar to those used by jet aircraft as braking aids during landings.

Meanwhile, engine specialists had been taking Detroit's standard engine blocks and wringing from them ten times their factory-rated horsepower, chiefly by installing superchargers that pumped huge quantities of air to mix with exotic fuels distributed to the cylinders by high-performance fuel-injection systems. The driver is free to choose the chemicals in the fuel mix, so the name "fueler" or "top fueler" became generic for this class of cars.

Today, all dragster components—even engine blocks—are made from space-age alloys. The sport's roots in the modification of stock mechanical components you can buy in the local store have been all but forgotten. Those roots survive today—barely—in another type of "fuel-burner" that's quite different from the dragster, at least in external appearance.

As dragster design became standardized to the point of monotony in the late 1960s, race promoters sought to bolster sagging interest by booking cars that looked like stock automobiles on the outside but had dragster engines hidden within them. Out of the ranks of these "exhibition stockers" emerged a new breed dubbed the "funny car"—essentially a dragster clothed in a lightweight fiberglass shell that mimicked a Detroit body.

Funny cars were an instant hit. Somewhat slower than dragsters, they made up for that shortcoming by their external kinship with race fans' family cars. The success of the funnies drove drag-race promoters to exhibit rocket-powered cars, jet-powered cars, cars built like delivery vans. For a while, almost anything that would run down a track was rolled out, and the more noise it made, the better. But no exhibition racers were ever allowed into sanctioned competition, and the top-fuel dragster continued to reign supreme, with funny cars in a separate class.

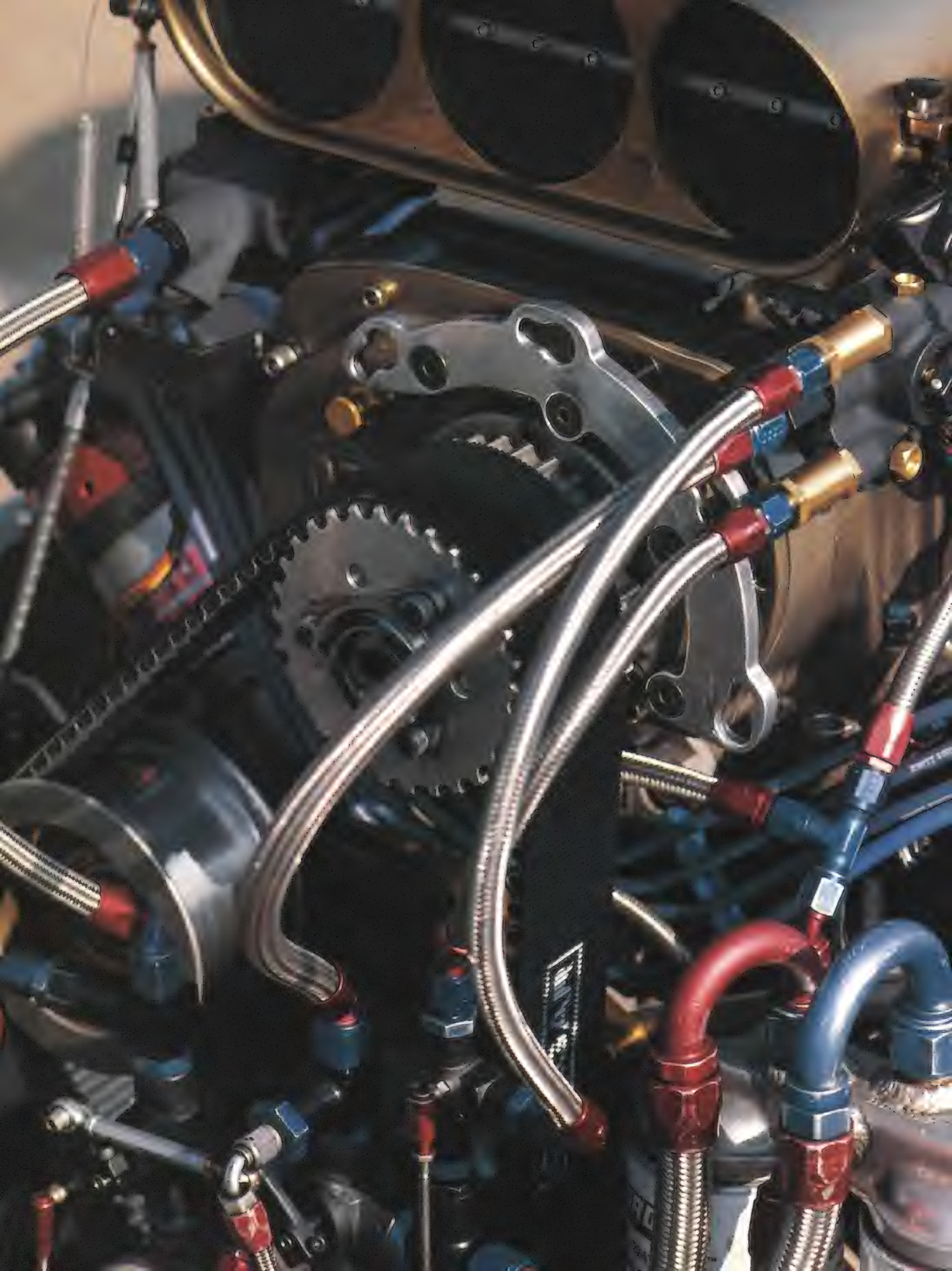
In serious competition of the sort seen at national championship drag

*Aerodynamics can be partly decorative, but front-end wings are now a virtual necessity at speeds of more than 250 mph (left).*

races, top speeds and start-to-finish elapsed times are both measured. But top speed is not really what counts; races are won only by cars with enough combined power and handling to deliver the lower elapsed times (called "ETs"). Lately, there has been a renewed interest in top speeds, or "big numbers" in track lingo. The best drivers—Don Garlits, Joe Amato, Dick LaHaie, Gary Beck—produce ETs in the 5.4-second range, with speeds of 260 mph.

Now, 260 mph is not much by the standards of, say, a fighter pilot, but

*An endplate derived from devices used on airplanes improves the effectiveness of a wing in applying downward pressure on the car (above).*



*From the aircraft industry came such high-performance engine parts as "armored" tubes and hoses (left).*

*zero* to 260 in 5.4 seconds is awesome. A dragster's weight-to-power ratio is substantially better than even the most potent propeller-driven airplanes, which helps to explain the fueler's enduring appeal in aeronautical circles. Air racer Bob Downey set quarter-mile records in these cars 20 years ago, and a dragster owned by Frank Taylor (famed for topping 500 mph in a modified P-51 Mustang) did the same more recently.

And there's a flip side: drag racers have characteristically had a lot of affection for aircraft. Don Garlits often takes his dragsters aboard aircraft carriers for picture sessions, and a rival driver named Connie Kalitta, who operates an air-freight service, has had a long-time penchant for things aeronautical.

Dragster designers initially tended to concentrate more on minimizing weight than on managing airflow, but they quickly recognized the usefulness of airfoils and wings. The conventional slingshot car was designed to transfer weight (hence, traction) to the rear wheels: they placed as little as ten percent of the car's dead weight on the front tires. When the car accelerated, this ten percent sometimes fell to zero, rendering the front wheels useless for steering. One rudimentary correction entailed attaching a flat plate to the front end, mounting it at a downward angle so that onrushing air pushed the front wheels down. But designers soon turned to wings with more sophisticated shapes, some of them with flat fins fastened to both ends (called "endplates") to contain the air and eliminate the turbulent vortices that the wings tend to induce. The first of these odd devices to attract attention was mounted on struts above the front axle of the *Tinkertoy,* the ultra-light creation of an innovative Georgia Institute of Technology engineer named Pete Robinson.

In the 1970s, there was a movement toward placing the driver up front, with the engine in the middle of the car, which changed the weight-transfer characteristics enough to reduce the need for aerodynamic help on the front end. But wings made an inevitable comeback as speeds continued to increase. Today it is standard practice to mount them ahead of the front wheels and just off the ground. Even larger wings seen on new fuelers are mounted toward the back of the car, but that arrangement was slower to catch on.

In 1963, a dragster showed up for a race in Pomona, California, sporting a large inverted airfoil mounted over the engine. The design came from Bruce Crower, a California inventor, and the dragster belonged to Don Garlits, who even then was known as "Big Daddy." Their aim was not merely to cancel front-end lift but to improve traction and stability by forcing the entire chassis downward. The designs were all strictly trial-and-error: Garlits and Crower merely chose a wing profile, molded it in fiberglass, and then set it up on struts of reasonable dimensions.

But it worked. The wing helped Garlits set a national record. When the assembly began to show signs of possible structural weakness, though, Garlits removed it without a moment's hesitation. The wiliest tactician of all drag racers, he eagerly experimented with anything that might confer an advantage, even if it was unproven. But once he had doubts about the wing, he was equally quick to sacrifice whatever advantages it conferred, along with its drawbacks—added weight, for one.

Newly available rubber compounds were soon yielding vastly better tire traction, and as speeds continued to move up, now pressing toward 250 mph, it was inevitable that interest in aerodynamics would intensify. Other centers of auto-racing innovation apart from the drag strip were contributing their own developments. Formula I racers, sports cars, and Indianapolis 500 racers—all of them sprouted wings.

*Dragsters get their complex curves from the molding of light, yet strong, fiber-reinforced materials.*

With the adoption of the mid-engine configuration and a revamping of the entire "combination" (the approach to the fueler as a technological system), everything suddenly seemed to open up on the drag strip in the early 1970s as an epoch of innovation began. There was a wave of interest in streamlined enclosures and bodies contoured like inverted wings that fully envelope the car. There were experiments with airfoils and wings of every configuration, profile, and placement, including above the cockpit and below it, over the engine and out behind the car. There were dragsters with wings mounted forward and aft, with wings on the sides of the car. There were even some trials with vertical stabilizers—tailfins!

Many of these experiments were short-lived: vertical stabilizers didn't seem to help, front-wheel enclosures called "pants" acted like rudders and


*It'll all be over in five seconds. Drivers liken Pomona's championship races to a ride on a bullet.*

turned out to be downright dangerous on the track, and the fiberglass envelopes designed to enclose the car completely were judged to be too heavy.

A rash of accidents occurred during this period as wing struts gave way under aerodynamic forces whose true magnitude had been a matter of guesswork—there had been little input from schooled aerodynamicists. Indeed, the whole epoch was reminiscent of that early period in aeronautics when, as historian Walter Vincenti has remarked, "Airfoil design was clearly more of an art than an engineering science." Drag racers tended to be suspicious of "science," and although there had been professional engineers among their ranks, even the best of them could not outperform those intuitive artists of dragster design, the acknowledged patriarch of whom was Garlits.

Nevertheless, while the successes of the early 1970s were remarkable—elapsed times dropped by nearly three-quarters of a second within the space of three years—there were indications that the limits of "cut-and-try" were being approached and that a little infusion of science might do some good. An ET record of 5.63 seconds set by Garlits in 1975 stood unbroken for seven years as racers seemed temporarily transfixed by the challenge of wringing out more and more brute horsepower. It's not as if their efforts to extract power from the already tortured engines were not remarkable. But if one watched closely during a race, a fueler could be seen pushing airborne particles along some 25 feet out in front of itself as it blasted along. As some observers put it, the cars "had the finesse of a pile driver."

In the 1980s, when the racers began to find it increasingly difficult to translate freight-train power into improved performance, the funny-car crowd took the lead in discerning new solutions. Early on, funnies had revealed an inherent tendency to trap air beneath their bubble-like bodies and literally take off. The remedy proved to be spoilers—panels of varying shapes that acted to interrupt the smooth flow of air. They were installed on the front of the body to block air from going underneath (these were sometimes known as "air dams") and on the rear of the car to "spoil" lift—which is how "spoilers"

*Parachutes that help slow jet fighters on landing evolved into dual braking 'chutes on dragsters and funnies.*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got their name in the first place.

Now some racers began landing corporate sponsorships and could afford "finesse"—and even a little science. For example, Anheuser-Busch and Hawaiian Punch, both sponsors of funny-car teams, footed the bill for time in Lockheed-Georgia's low-speed wind tunnel for their race teams. And a new funny-car configuration emerged: bigger spoilers, more carefully engineered air scoops, and closer attention to the fine points of aerodynamics throughout.

New departures quickly became evident on dragsters as well, especially when, in 1984, driver Joe Amato set up his main wing well behind the car and seven and a half feet high—up in smooth air. He also set the wing at a much shallower angle with respect to the passing airflow, with the result that downforce was greatest at high speeds when it was most needed and drag was reduced. The rewards were immediate: Amato quickly shattered Frank Taylor's record of 257 mph, posting a speed of 264 and, early this year, 269 mph.

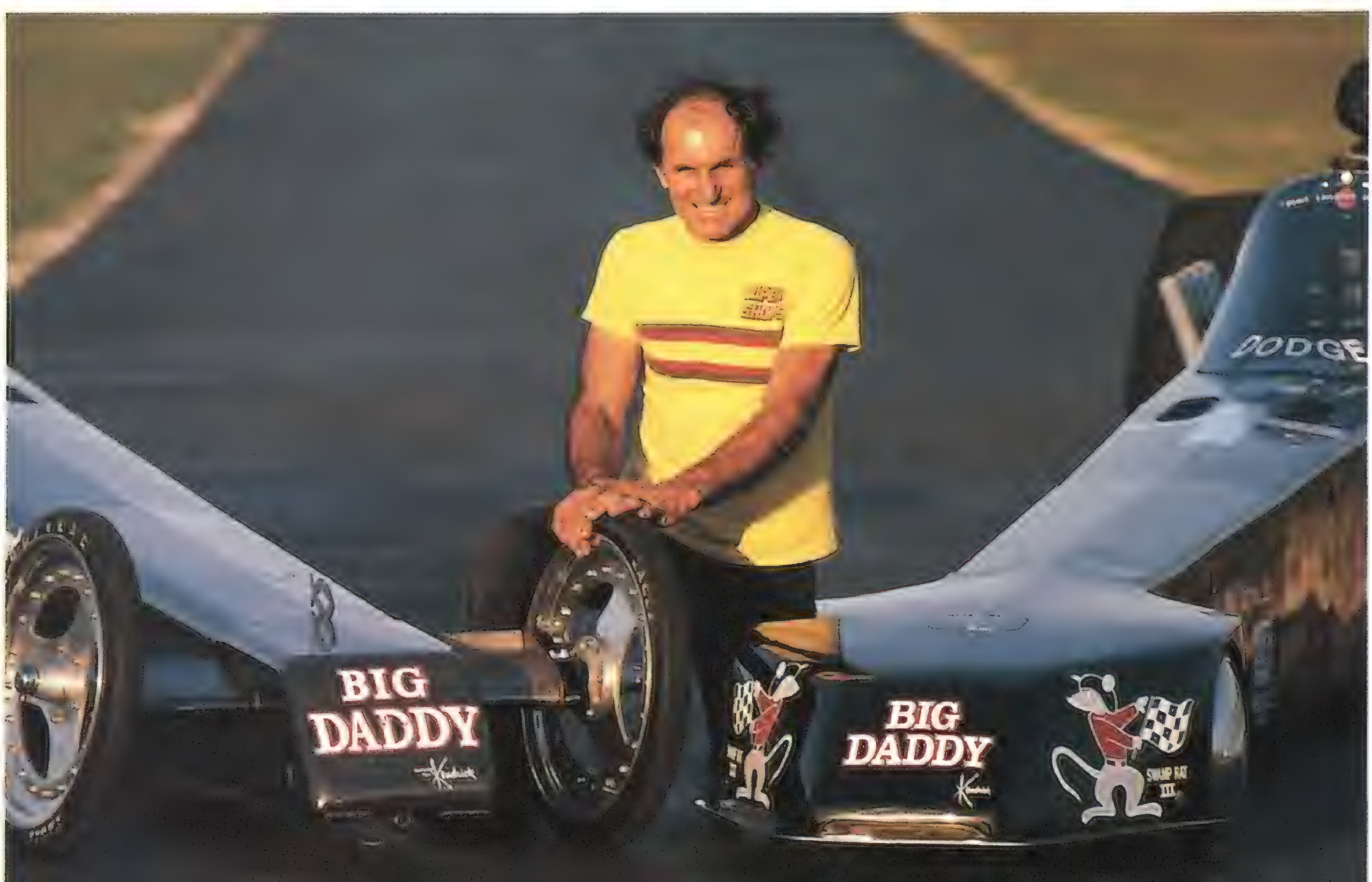
An even more stunning aerodynamic breakthrough was in the offing, at the hands of—who else?—Don Garlits. In March of this year, he debuted a new semi-streamlined fueler and promptly went 272.56 mph. The car was a triumph of aerodynamic thinking all the way to its new downsized front wheels, which look like they've been yanked off a small airplane. But they reduce the car's frontal area, the first part to greet the air when the throttle goes down.

With the ready availability of materials that are stronger than fiberglass at less than one-tenth its weight, dragster designers inevitably began to reconsider streamlining. Some turned attention to the afterparts—the engine and rear tires—which present the largest surface area to the onrushing air. But Garlits has been more conservative, concentrating his initial efforts on the front end. At one time there had been speculation about what might result if Garlits were to team up with an aerodynamicist with as much savvy about airflow as Garlits has smarts about driving. In fact, he drew on the experience of aerodynamicist Mike Magiera in designing this car. Magiera had acquired extensive experience testing automotive contours in wind tunnels. Still, Garlits' own design prowess made its contribution: he says the basic configuration "came from out of my head."

No previous streamliner, including Garlits' experiment with a full fiberglass envelope some years ago, has ever lived up to expectations—not like this one, anyway. The involvement of an aerodynamicist in its development has touched the sport with science, and drag racing may never be the same. Garlits himself now intends to begin smoothing airflow around the engine and rear tires. How much further he and others can go is an open question, but "airflow management" is clearly the coming frontier. These efforts will certainly include airfoil and wing development, since experimentation with wings has paid off handsomely so often in the past.

Predicting 280-mph top speeds for fuelers this year, Garlits was regularly topping 270 mph by late spring. It seemed routine, as if he were just practicing. "We have just touched the tip of the iceberg," he said. If he's right, then we've only glimpsed the potential impact of applied aerodynamics on this singular automotive technology.

*Don "Big Daddy" Garlits turned to science for a record-setting car (on right) with a radical front end.*

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# Celestial Visions

## Chesley Bonestell's art took us into space long before technology did.

By Mike McIntyre

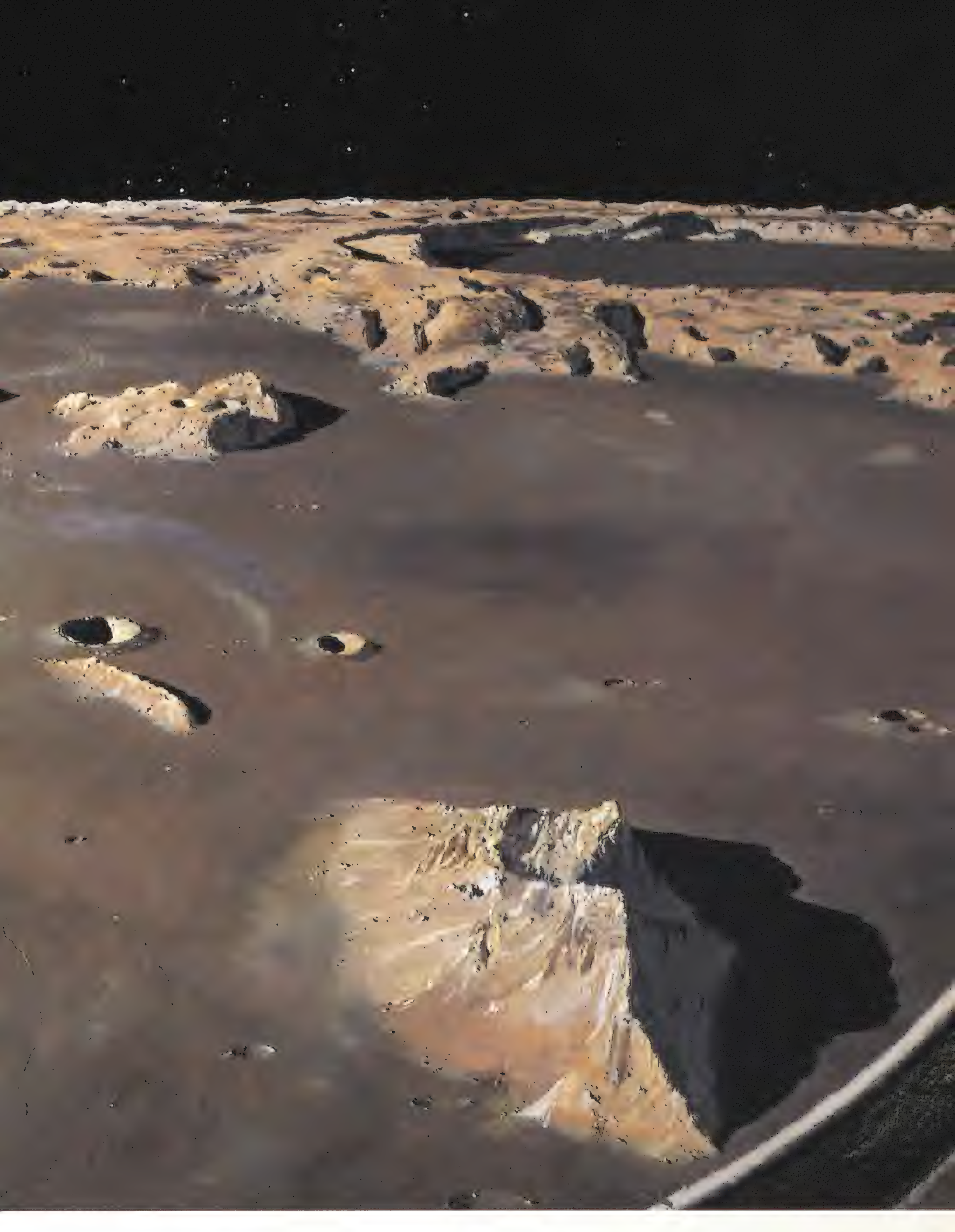
Chesley Bonestell may have been the twentieth-century's answer to Leonardo da Vinci. In an age when versatility has been replaced by specialization—when people seem satisfied to excel in narrowly defined roles—Bonestell displayed a range of interests and a level of accomplishment that has seldom been duplicated. When he died on June 11, at age 98, he had enjoyed enormously successful careers in architecture, the motion picture industry, and, most important, space art. Bonestell was one of those rare individuals genuinely worthy of the title "Renaissance man."

Like da Vinci's detailed designs of flying machines, Bonestell's paintings of space travel demonstrated an intuitive ability to picture what was yet to be seen. Unlike da Vinci, however, Bonestell had the good fortune to witness many of his artistic imaginings come to pass.

Bonestell's paintings are at once beautiful and prophetic: beautiful in their meticulous detail and use of light and shadow, and prophetic in their astonishing resemblance to photographs of the planets, particularly Jupiter and Saturn, sent back to Earth decades later from spacecraft such as *Voyager 1* and *2.* Not all of Bonestell's renderings hit their mark—as was the case with his moon paintings, which depicted a craggy surface instead of the meteor-worn topography revealed in 1966 by the lunar probe *Surveyor.* But even when he missed, the visual results were impressive. Indeed, Bonestell's paintings—done with thin layers of oil on heavy illustration board—seem so real that their effect has been described by one enthusiast as being "a kind of transportation, with an authenticity that makes viewers think, for a moment, that they were actually there among the planets."

Bonestell's fascination with celestial matters began as a


Over Mount Pico. *1945. The surface of the moon appears 25 miles beneath a spacecraft's window. This early painting was one in a series that helped awaken scientists to the possibilities of space flight.*



youngster in San Francisco. "Seeing the planet Venus, so brilliant and ever-changing in the morning and evening sky, excited my curiosity," he recalled recently, "and at about age 10 I started to read books on astronomy."

Another event that would shape his career—although he didn't suspect it at the time—occurred when he was 17: "I had been illustrating articles in *Sunset* magazine, which was then owned by Southern Pacific Railroad. They paid me in railroad passes, and one day a friend and I caught an early train to San Jose and hiked 26 miles to the summit of Mount Hamilton and Lick Observatory. That night I saw the moon through the observatory's 36-inch telescope, but even more impressive and beautiful was Saturn through the 12-inch refractor. As soon as I got home, I painted a picture of Saturn." That painting, along with others that quickly followed, was destroyed in the San Francisco earthquake and fire of 1906. But the celestial muse had taken hold of young Bonestell for good.

To make a living, however, he turned to bringing more down-to-earth objects into focus as a designer and architect. For example, during the Depression he worked on construction of the Golden Gate Bridge, drawing detailed cutaway sections of the structure to show a skeptical board of directors how its money was being spent. Earlier, he had laid out the famed 17-Mile Drive in Pebble Beach, California, and helped design such American landmarks as the U.S. Supreme Court and New York City's Chrysler Building. (Bonestell named William van Alen, architect of the Chrysler Building, as one of the men he most admired, along with Winston Churchill and Robert Louis Stevenson.)

In 1938, at age 50, Bonestell went to Hollywood. As a special-effects artist, he produced background paintings for such classic films as *The Hunchback of Notre Dame* and *Citizen Kane,* and he eventually became the highest paid "matte artist" in the industry. He also found a way to express his fascination with space: his paintings appeared in many of the early science fiction movies, including *War of the Worlds* and *Destination Moon.*

The skills Bonestell refined in Hollywood were instrumental in his next—and most famous—career. "As my knowledge of the technical side of the motion picture industry broadened," he said, "I realized I could apply what I learned about camera angles to illustrate 'travel' from satellite to satellite, showing Saturn, for example, exactly as it would look."

Bonestell's space paintings began to appear in magazines such as *Life, Look,* and *Scientific American* in the 1940s, when most professional engineers and scientists were yet to embrace the possibility of space flight. His illustrations of science-writer Willy Ley's concepts of rockets and space stations—which culminated in the 1949 milestone book *The Conquest of Space*—prompted many in the technical community to take a serious look at the viability of space flight. "The paintings of Chesley Bonestell affected us all powerfully as the predawn of space flight lightened the horizon of post-World War II technology," Robert W. Bussard, the innovative designer of starship propulsion systems, once said. "In the late 1940s senior voices decried such follies. Chesley Bonestell's paintings kept our fires alive and lent us hope that it could

Martian Colony. *1963. Working with Wernher von Braun, Bonestell depicted the production of food and oxygen in gardens and fishponds within domes surrounding the pioneers' living quarters (above).*

Second Stage Separation. *1951. As a third-stage rocket separates, bound for a space station, the second-stage ring parachute deploys for a splashdown, the same way the shuttle's booster rockets are salvaged today (right).*

happen, if only we would try."

No longer a mere artist, Bonestell became the artistic extrapolator and communicator of the concepts of those on the cutting edge of an evolving space program. He teamed with rocket pioneer Wernher von Braun on a series of articles on the feasibility of space flight—including proposals for missions to the moon and Mars—published in *Collier's* magazine in the early 1950s. "Von Braun would send me sketches of spacecraft drawn on graph paper, which I converted into working drawings and then into paintings with detailed perspective," Bonestell recalled. Explaining how he was able to depict the surfaces of Earth, Mars, and the moon as they would appear from those imagined spacecraft, he said: "I considered the planets as globes covered with a series of flat planes one to ten miles square, with the centers of the squares being tangent to the globe. It was then easy to find the horizon and the vanishing points of the sides of each square, and the rest was just a matter of plotting the physical features on the squares."

So precise were his renderings of everything from booster rockets to distant worlds that von Braun wrote in the foreword to Ley and Bonestell's book *Beyond the Solar System*: "Chesley Bonestell's pictures . . . are far more than beautiful, ethereal paintings of worlds beyond. They represent the most accurate portrayal of the heavenly bodies that modern science can offer. I do not say this lightly. In my many years of association with Chesley, I have learned to respect—nay, fear—this wonderful artist's obsession with perfection. My file cabinet is filled with sketches of rocket ships I had prepared to help him in his artwork—only to have them returned to me with penetrating, detailed questions or blistering criticism of some inconsistency or oversight."

When *Apollo 11* touched down nearly two decades later, Bonestell was overwhelmed. "When Neil Armstrong put his foot on the moon, tears poured down," he said. "I wept. I broke down and cried. It was the realization of something I had been hoping for during a large part of my life."

Although Bonestell said he would have enjoyed traveling to the planets, he quickly added that given the chance he would not have signed on as an astronaut. "I am a born artist," he maintained, "and would never want to be anything else." He did, however, see a potentially important role for artists in space: "Photography may be more exact, but an artist can create or recreate a mood, or hold a scene in his mind and create it later." As might be expected, he believed that artists "should not be invited to accompany astronauts unless they are thoroughly conversant with the basics of astronomy, and of course their art should be first-class."

Today's space artists will undoubtedly have the opportunity someday to study their subjects up close. But when

The Exploration of Mars. *1956. In a scene that may become reality early in the twenty-first century, geologic investigations begin at a temporary base (left).*

Arrival at Mars Orbit. *1953. Working with von Braun's sketches on graph paper, Bonestell depicted several winged craft en route to a landing while satellites orbit the planet (below).*

that day arrives, they may find that Bonestell's paintbrush has beaten them there. "As far as I can remember, I covered just about every space subject or question that could be asked," the man many consider the "dean of space art" once observed.

Of artists outside the space genre, Bonestell considered "the greatest" to be Salvador Dali. "He can work much better than I do," Bonestell said. "That's a big admission for me to make." But he disdained most contemporary art: "Modern painting, so-called, gives every faker a chance to put a dash of color here and splotch there."

Bonestell's own paintings may never command the artistic acclaim accorded those done by the famous "paint drippers," as he liked to call them. But how many other twentieth-century artists can honestly say their work influenced literally millions of people?

After a life filled with activity, Bonestell was in recent years content to lead a quiet—and very private—life with his third wife, Hulda, at their home in the scenic mountains along the northern California coast. He painted as much as his faltering health allowed—"for my own amusement," he said.

On such occasions he could be found in his studio, a lofty structure set on stilts above the treetops. The walls were crowded with his paintings—space paintings as well as others displaying the range of his interests: the Taj Mahal, California's early Spanish missions, a creative revision of St. Peter's Basilica (a photo of which he sent

*Chesley Bonestell couldn't picture himself as an astronaut, but did see a mission for good artists soundly versed in astronomy.*

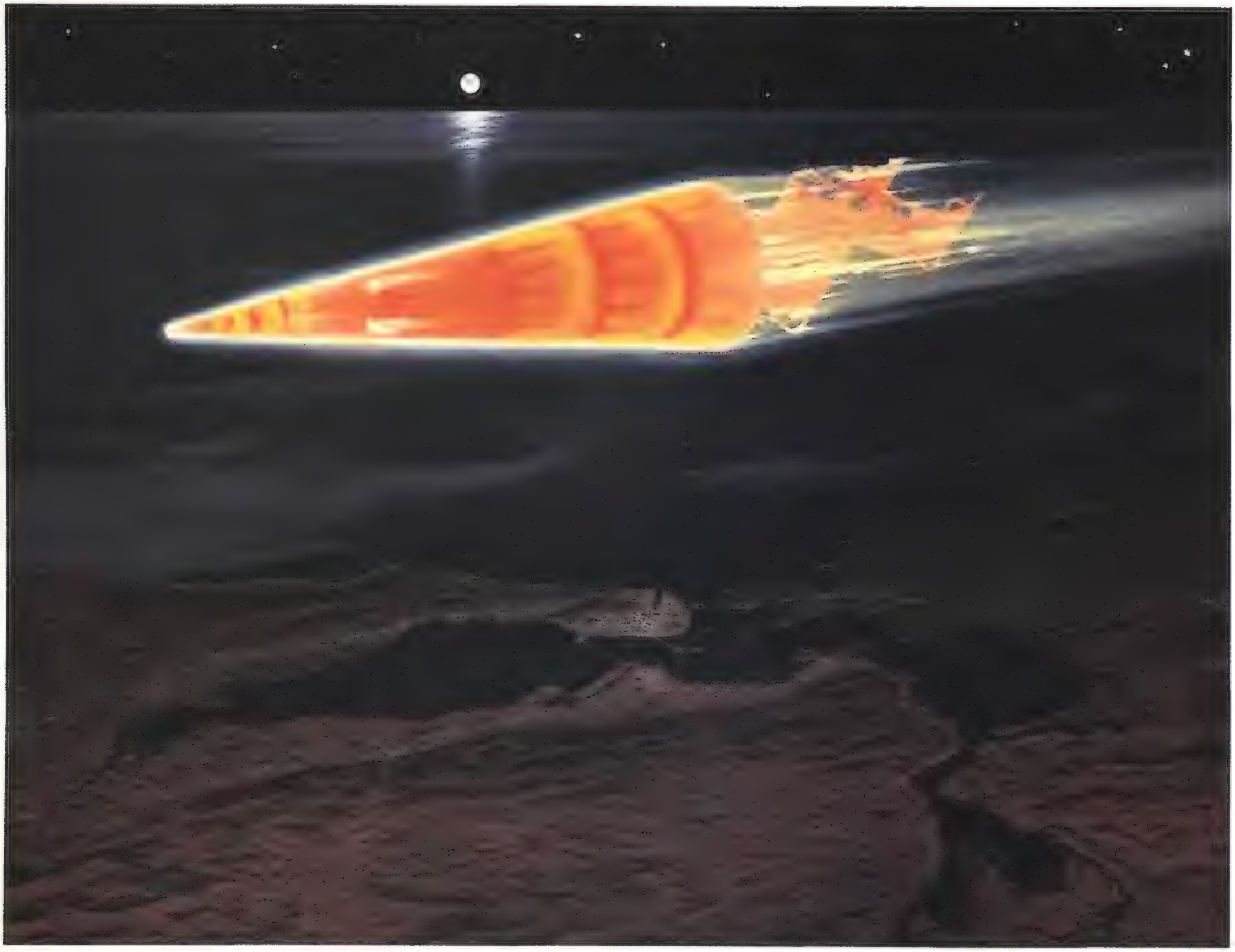
Re-entry over San Francisco. *1953. Streaking through the sky like a meteor, a small satellite that has finished its mission disintegrates as it enters the atmosphere.*

to Pope Paul I, along with "instructions for remodeling").

At his easel, Bonestell, with a full head of white hair, peered through black-rimmed glasses, his painting hand steadied by a round stick that he maneuvered across the canvas with his left hand. "I believe that everyone, to be happy throughout life, should have a hobby to enjoy," he was fond of saying. "Then, at least from a purely selfish standpoint, your life will be a success."

To say that Bonestell's life was successful is an understatement. And recognizing that his magnificent visions of the science and beauty of space have inspired generations, the Planetary Society named an asteroid in his honor not long before he died. The asteroid is in what's known as the Main Belt that lies between Mars and Jupiter, and orbits the sun every 4.4 years. Formerly called (3129)1979MK2, it is now and forever "Bonestell."

In a telegram notifying Bonestell of the action, astronomer and society president Carl Sagan wrote: "It is only fitting that we give a world to you, who have given us so many."



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By Terry Gwynn-Jones

# New Guinea's Great Aerial Gold Rush

All photographs from the Gwynn-Jones collection.

# There was gold in those jungles, and airplanes—all sorts of airplanes—provided the only way to reach the rainbow's end.

*Gold-rush pilots soon learned that moments of serenity were but a prelude to hellish flying conditions over jungles and mountains. Some would succeed but many would perish.*

It was a typical steamy day when Les Trist climbed aboard his Junkers W-34 cargo plane at New Guinea's Lae Airfield and took off on the 50-mile flight to the Bulolo gold fields. He never arrived. Airplane and pilot vanished, swallowed up by the jungle somewhere in the mountains between Lae and his intended destination.

Three months later Ian Grabowsky, the missing pilot's replacement, was finding the heat sweltering as he mowed the grass along the edge of the airstrip. But he quickly forgot his discomfort when he spotted a group of native tribesmen emerging from the jungle. Armed with long spears and wearing little besides cowry shells and spectacular clusters of bird-of-paradise feathers in their hair, they looked like headhunters from the nearby highlands. It was too late to run, so Grabowsky put on a brave front as the group approached.

A warrior carrying a woven bag called out in a strange language, pointing first at his bag, then at his own head, and finally at the airplanes. When he reached Grabowsky, the warrior opened his bag and dumped out its grisly contents—the head of Les Trist.

Despite the communications barrier, the tribesmen managed to make their story known. They had not murdered Trist, they signaled, but had discovered his wrecked aircraft near the crest of Wampit Gap. He had apparently encountered dense fog and smashed his W-34 into a mountainside. The tribesmen's gory message had been their only means of communicating Trist's untimely fate.

The year was 1931. New Guinea, located in the South Pacific immediately north of Australia, was a forbidding and unexplored island. A place of Stone-Age tribes, razor-backed mountains, and steamy jungles, New Guinea was—and still remains—one of the world's most treacherous places to fly. Yet Australian bush pilots flying a motley collection of aircraft from primitive airstrips were setting world records. They were flying aviation's first great airlift, a mammoth supply operation that eventually would carry the savage island into the twentieth century.

The airlift was motivated by an overwhelming obsession that has seduced people throughout history—gold fever. Since the sixteenth century, when Spanish and Portuguese sailors reported seeing natives wearing the glittering metal, rumors had persisted of an El Dorado in New Guinea's unexplored mountains. In the 1870s, rich gold fields had been discovered in the far north of Australia, in what is now Queensland, and speculation about the possibility of hidden gold fields increased after a British geologic survey revealed that formations in New Guinea were similar to the Australian deposits. The sailors conducting the survey had also found traces of gold in a nearby bay.

As the Australian gold rush waned, gold hunters by the hundreds sailed to New Guinea, prepared to risk their lives in search of a quick fortune. Few struck it rich—more died of malaria or at the hands of native tribesmen. Among the few who stayed was William Park, a prospector nicknamed "Sharkeye" for his penetrating stare. Park spent 20 lonely years searching before he made his first find, deep in the inaccessible mountain ranges of the Morobe district.

Park tried but failed to keep his discovery a secret. According to James Sinclair's *Wings of Gold*, by 1925 some 50

miners (or "diggers," as they were called) were working claims along the Bulolo River and its tributaries, located in a valley cut off from the coast by forbidding mountains rising as high as 7,000 feet. Native porters provided the only means of bringing supplies in and taking gold out. The trek meant two weeks struggling over tortuous trails, and each porter could carry only 50 pounds, one-quarter of which was the rice he needed for the journey.

Cecil J. Levien, deputy district officer for the Morobe district, suffered from a touch of gold fever himself, and had allegedly requested his out-of-the-way post for the express purpose of keeping an eye on the prospectors. When he learned of Shark-eye's discovery, Levien quit his post and joined the gold hunters. Indeed, he was a man with a plan. While most of the diggers worked the creek beds for easily won but modest rewards, Levien realized that the real rainbow ended in the valley's mud flats into which the mountain creeks drained—carrying vast quantities of gold along with their water. Levien also knew that extracting the gold from the flats, where mud often reached depths of 100 feet, would eventually require construction of huge mechanical dredges.

In 1926 Levien helped form a syndicate, encouragingly named Guinea Gold No Liability, to exploit the deposits at

*"Battling" Ray Parer lived up to his nickname under the primitive conditions in New Guinea (above).*

*Les Trist and a Westland Widgeon in happier days: getting lost in fog literally cost him his head in 1931 (below).*


*After a hard day's flying, pilots then had to survive the less-than-luxurious facilities at Wau airstrip.*

Bulolo flats. Building a road to the fields would have been prohibitively expensive, so the partners decided to fly in the tons of parts and equipment for the dredges. It seemed an impossible dream by the aviation standards of that day, when few aircraft could lift a 1,000-pound load, much less deposit it on the other side of a mountain ridge. Nevertheless, Levien pushed for just such a miracle, forming Guinea Gold Air Service. The company began with the purchase of one de Havilland DH-37 biplane and the hiring of a former Australian Air Force pilot, A.E. "Pard" Mustar.

Another Australian pilot, Raymond Parer, soon heard of the gold boom and its need for air support. He was known as "Battling" Parer after his dogged performance against various mishaps during the 1919 England-Australia Air Race. (In Australian slang a "battler" constantly encounters misfortune but valiantly carries on and never forgets to help his mates.) Parer had already made an unsuccessful attempt at starting a flying service in Australia, which had ended when he crashed his FE-2B pusher biplane into a butcher's wagon during a barnstorming tour. It could have been a hint of things to come in New Guinea, but he didn't take notice.

Parer pooled his meager resources with Eric Gallet, a farmer looking for adventure, and they bought an ex-World War I de Havilland DH-4 biplane. They arranged to ship the aircraft by sea from Sydney to Rabaul on New Britain Island, off northern New Guinea, and from there planned to fly the 400 miles to Lae.

Parer and Mustar, both still in Australia, were soon racing each other to reach the gold fields first and capture the lion's share of the miners' flying business. Parer gained the advantage in Sydney by booking the only deck space available on the next Rabaul-bound freighter, but lost it when he could not pay the shipping fees. The captain immediately offered the space to a gleeful Mustar.

Parer and Gallet managed to scrounge enough money to take the next ship, reaching Rabaul six weeks after their rival. They were delighted to learn that Mustar was still there, awaiting completion of the airstrip at Lae. Their elation subsided somewhat when they unloaded the airplane. Never meticulous about maintenance, Parer had failed to check tire pressures during the voyage, and the flattened tires had been cut by the sharp wheel rims. By the time new tires arrived from Australia, Mustar was in Lae, busily flying miners and their supplies to the gold fields.

The flights were always a nightmare. With the mountains frequently shrouded in turbulent clouds that topped 12,000


*Even after pilots managed to find Wau's tiny airstrip, its uphill slope could make landings difficult.*

feet, Mustar in his heavily laden DH-37 often had to search below cloud level for an opening through the range. He soon discovered a route that cut through the Wampit Valley, but it took several flights before he was able to locate the tiny airstrip that workers had carved from the jungle in the settlement of Wau, located near the gold fields.

"It was the world's worst aerodrome," Mustar wrote later in Australia's *Aircraft* magazine, adding that from the air it looked like "a miniature tennis court." The cleared area, only 800 yards long and sloping upward, lay at an angle along the side of a hill. Hemmed in by mountains, the strip's only safe approach required a sharp last-minute turn.

Deceived by the uphill slope, Mustar nearly flew into the ground during his first landing. He came down short and heavy, bounced, then was surprised to find that he needed full power to taxi up the hill to the far end, where the porters waited to unload his 600 pounds of supplies. He also had to park his airplane sideways to keep the brakeless machine from rolling back down the strip.

When Ray Parer reached New Guinea two months later—in June 1927—his battling spirit had already been severely tested. During his first test flight at Rabaul he had hit a soft spot while landing, overturning his DH-4. (Gallet, who suffered a broken collarbone in the accident, decided he had experienced enough adventure and returned to Australia.) And by the time Parer started his venture—called Bulolo Goldfields

Aeroplane Service—Mustar's company was averaging two trips daily, in one week carrying 2,850 pounds of freight and 15 passengers. However, Mustar had set his prices deliberately high, affordable by the larger operations affiliated with Guinea Gold but discouraging to the numerous small-time miners. The independents soon turned to Parer. They often loaned him money to keep his ramshackle aircraft in the air, and in return he undercut Guinea Gold.

The New Guinea airlift was up and running. By early 1928 other Australian pilots had arrived at Lae to fly for the independent miners. Often lacking the resources to purchase suitable aircraft, they sometimes operated machines as tiny as the de Havilland DH-60 Moth, which was hard-pressed to lift 350 pounds of freight, and a 1914 Avro 504 trainer, which carried even less. The pilots quickly discovered the tribulations of coping with trackless jungle devoid of emergency landing areas and fierce tropical storms that occurred almost daily. They would frequently leave Lae in bright sunshine only to find themselves enveloped by clouds and torrential rain in the mountains. Highland warriors even attempted to attack low-flying aircraft. In his book *The Wandering Years,* Arthur Affleck recalled one incident when he flew over a tribal battle. "As though all the contestants were actuated by a mastermind, they ceased their battle, looked up at me, and then loosed a cloud of arrows," he wrote. "In spite of the fact that I was obviously out of range, I got such a fright that I never allowed my curiosity to entice me anywhere near a hilltop village or a crowd of ***kanakas*** [indigenous tribespeople]. I learned, later, that most New Guinea pilots of those days had been through a similar experience."

Living conditions were equally ghastly. Pilots and ground crews lived in bamboo and palm-thatched huts furnished with mattresses and a few old packing cases. The shacks were infested with stinging insects and lizards that lived on the thriving population of fat green flies. A communal mess hall was run by a slovenly couple with only one apparent cooking utensil—a can opener. Malaria and dengue fever ran rampant amongst airmen and miners alike.

The unhealthy combination of perpetual dampness and equatorial heat also played havoc with the aircraft, shortening engine life, rotting fabric, and generally making maintenance difficult. Forced landings became commonplace, but slow air speeds and the ability of biplanes to absorb impact saved most pilots. Survivors still faced terrible hardships getting back to civilization, including the problems of hostile tribesmen.

Still, gold exercised its power. And the airlift soon gathered new momentum when Mustar's infant organization, re-named Guinea Airways, purchased its first Junkers, a single-engine W-34. Its all-metal construction made it look like a corrugated tin shack with wings. Despite its appearance, the Junkers was a big step forward for the business. "I estimate the usefulness of this machine to be about four times the usefulness of our DH-37," Mustar reported after testing the aircraft. In its first eight months of operations, the W-34 carried 500 passengers and over 300 tons of freight—more than all of the other operators combined.

In an effort to compete with Guinea Airways, "Battling" Parer borrowed more money from some miners and rushed to Australia in search of new aircraft. Unable to afford a proper cargo airplane, he returned with a pair of dubious ex-World War I machines—a Bristol F-2B fighter and a de Havilland DH-9 bomber. Although both types had been successful military aircraft, neither had been built to carry freight and were awkward, at best, to load.

Parer's three-aircraft fleet was soon drastically reduced. A new pilot smashed the Bristol during an attempted landing at Wau, and the old DH-4 was grounded while awaiting a new engine. Parer eventually made enough money to purchase a second DH-9, but his legendary bad luck struck again.

Looking to advertise his new aircraft, Parer persuaded Sir


*Pilots could haul almost anything—for the right price—in a Junkers G-31. Need a cow or car? No problem.*

Hubert Murray, the lieutenant governor of the Papua section of New Guinea, to go for a spin. Sir Hubert took along his niece. The trio had barely left the ground when the airplane's engine quit, leaving Parer no option except to land in the trees at the end of the airfield. He tore off both sets of wings and crumpled the forward section of the fuselage.

Parer crawled from the wreckage and tried to help his passengers. The young woman was speechless but unhurt, while her uncle stared haughtily at Parer from the open cockpit. "Excuse me, sir, don't you think you'd better get out?" Parer queried.

"Oh, is it all over?"

"We've had a crash," Parer explained lamely.

"Oh. I thought it was just another of your stunts, Parer," said Sir Hubert.

Compounding Parer's troubles, Mustar kept expanding. And in 1931 Guinea Airways purchased the aircraft that were to help make aviation history in New Guinea—the tri-motored Junkers G-31 cargo planes, modified versions of an airliner already being operated by Lufthansa. Goliaths by 1931 standards, the new airplanes could accommodate a massive 7,000-pound load, yet still operate from the gold fields' short strips.

On March 31, the G-31 *Paul* became the first to touch down on the newly improved airstrip at the Bulolo flats, loaded with parts for the first of eight dredges. Two months later, a pair of G-31s joined the airlift, now flying as many as five flights a day with parts for the 1,100-ton dredge, plus all the supplies for the hundreds of men working at the site. Over the next year, Guinea Airways carried a staggering 3,947 tons of freight and 2,607 passengers. That same year the air services of Great Britain, France, and the United States carried a combined total of only 2,670 tons of freight.

As the pace of New Guinea aviation accelerated, so too did the number of accidents and fatalities—including the death of Les Trist. The sketchy records remaining indicate that about 50 of the 250 aircraft that would eventually participate were destroyed in crashes. Many more were tossed onto the scrap heap, no longer airworthy after too many accidents and too little maintenance.

But the great airlift did have its lighter moments. On one flight to re-supply an expedition in the Central Highlands, Ian Grabowsky landed on a plateau to find more than 1,000 war-

*Ray Parer (standing, left) flew this DH-9 on the first flight across New Guinea. It was one airplane he didn't crash.*

*Pilot Rex Boyden survived the crash of his Junkers G-31. His cargo of beer for the Wau pub was not so fortunate.*

riors lining the strip. "Grabowsky, one of the tallest men in New Guinea, climbed out of the cockpit," recalled expedition member Mick Leahy. "He was wearing a white flying suit and a white helmet, with large, square-cut green goggles. Even to us he looked like an artist's conception of a man from Mars. The *kanakas* simply flattened onto the ground and moaned, and for some moments were afraid to look upon this great giant from the skies." Only when more than 50 of the tribesmen were allowed to run their hands over the indignant pilot's body were they satisfied that he was human.

On March 21, 1932, a rip-roaring party was held at Bulolo to mark the start-up of the first dredge. Every available aircraft flew in visitors for the speeches, innumerable toasts, and mountains of food and beer imported from Australia. Sadly, one face was missing—Cecil Levien, who had started it all, had died of meningitis a short time before. During the celebrations a G-31 took off and circled the dredge. Before setting course for Lae, its pilot scattered the visionary Australian's ashes over the gold fields.

With Guinea Airways virtually controlling the heavy-freight business, Ray Parer and the other operators were still making a living flying smaller loads of mixed freight in an assortment of aircraft. Parer, who had launched a new business called Pacific Aerial Transport, found his luck running true to form when he wrecked his new Fokker F III on its maiden flight. With the help of his miner friends he purchased another Fokker and a single-engine Junkers W-33. Named *Lady Lettie*, the W-33 performed well until hitting the company hangar at Wau during a takeoff. It took three and a half years to rebuild the wrecked hulk.

The ultimate bush pilot, Parer frequently carried cargo no one else would touch. He once transported a cow. Angered at being crammed into the aircraft, the beast rammed its horns through the plywood partition behind the cockpit and through the back of Parer's seat, jabbing the worried airman continually until he landed at Wau. On another flight a wild boar ran loose until its legs broke through the airplane's floor, pinning the animal for the rest of the flight.

Parer had a unique method of testing untried landing areas. He would fly low over the ground and drop a large bottle of beer. If the bottle broke, he knew the ground was hard enough for a landing. However, his unorthodox methods and cavalier approach to servicing his aircraft undoubtedly contributed to Parer's numerous mishaps. During one stretch while operating in the uncharted area around Sepik Valley, he had 17 forced landings. Somehow he always managed to get his machine down in one piece and patched up sufficiently to fly out again. He once repaired a broken fuel line with a piece of bamboo, and another time carved a replacement bearing for his generator from a piece of an ironwood tree.

In 1934 Parer's steady rival, Pard Mustar, had a disagreement with Guinea Airway's directors and returned to Australia, with Ian Grabowsky taking his place. Over the next seven years, which saw the construction of seven more dredges, the company continued to set a string of world freight-carrying records. Indeed, Lae was unofficially the busiest airport in the world, in terms of annual takeoffs and landings.

In the meantime, Parer had left the freight business to try his hand at mining. But the lure of flying proved too strong, and he purchased a pair of Boeing Model 40 biplanes. Unfortunately, his luck still ran sour: an inexperienced pilot flew one of the biplanes into a mountain—on its first cargo flight—destroying the aircraft and seriously injuring himself. The other Boeing spent most of its time grounded for repairs—until World War II flared up and Japanese bombers turned the aircraft into matchwood.

Japanese forces landed at Rabaul in January 1942 and prepared to move on New Guinea. Australian women and children were evacuated, but the gold fields stayed active until the last minute, still serviced by Guinea Airways. The company's last report showed that since 1929 its airplanes had carried 105,314 passengers and 73,480 tons of cargo.

War came to the Bulolo airfields in the early afternoon of January 31, after a Guinea Airways pilot landed the G-31 *Paul* and taxied it alongside the company's two other Junkers. The airplanes were being refueled for the last time when three Zeros came roaring low over the valley, machine guns blazing. The G-31s burst into flames.

The New Guinea Gold Rush was finally over: World War II had begun.

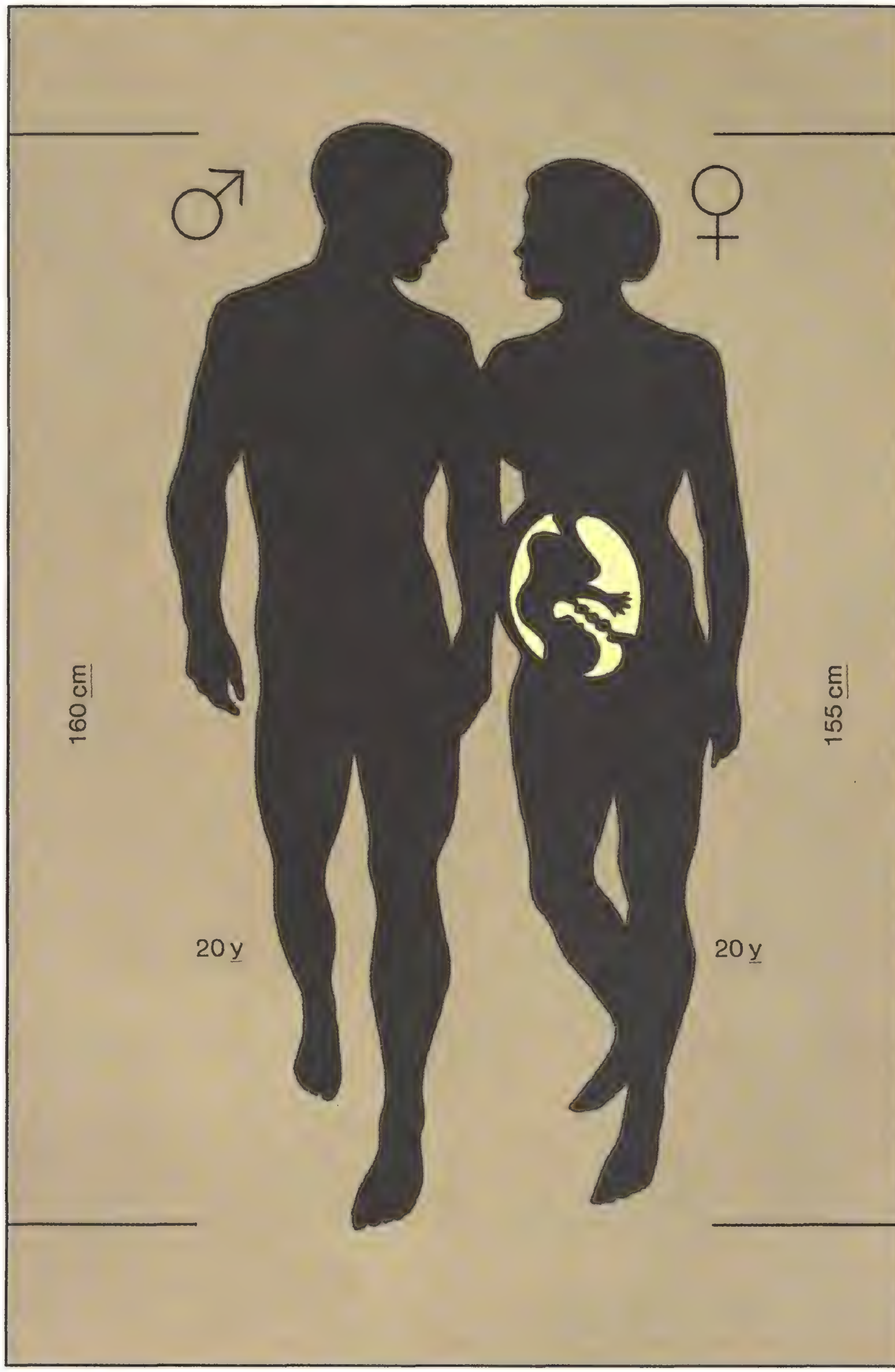
# Seeking Our Fellow Voyagers

With a blast of fire from its rocket, the spacecraft began a great voyage. The energy flowing downward from the rocket created another kind of energy flowing upward—motion—and the rocket soared into the sky. The fire burned for 15 minutes, adding more and more motion to the rocket, and when the rocket reached space and the fire shut off, the motion did not. This motion might last billions of years, carrying the spacecraft past the outer planets of the solar system and out of the grip of the sun, to wander almost endlessly through the galaxy.

A few weeks later, on September 5, 1977, an identical spacecraft roared skyward. Once again, human beings witnessed the creeping beginning of a motion that would weave through distant, unimaginable places and times.

These two spacecraft, named *Voyager*, were built to explore the outer solar system. Both swept past Jupiter and Saturn, and *Voyager 1* continued on to its rendezvous with Uranus last January, and will reach Neptune in 1989. With a variety of instruments the twin spacecraft studied the planets' swirling, colorful bands and spirals of gas, and the rings, the moons, and the electromagnetic fields around each planet. The *Voyager*s replaced chalkboard theories and blurry telescopic images with vivid photos of kaleidoscopic gasses, majestic rings, and moons of ice or rock covered with cracks or craters, volcanoes or thick clouds.

When the *Voyager*s complete their exploration of the planets, their journey is still only beginning. Their momentum will make them among the first human-made objects to leave the solar system. Heading in different directions, they will wander on and on through space, occasionally passing other stars. The spacecraft will not see these stars, for their instruments will be dead. And Earth will long since have lost track of the *Voyager*s. They will be terribly




*Two* Voyager *spacecraft are carrying images and sounds of the Earth to our unknown kin across the cosmic sea.*

alone, perhaps the only matter within many light-years shaped by a force other than gravity, radiation, collisions, extreme heat and cold, tectonics, wind, water—the only matter that bears the mark of life.

Indeed, the *Voyagers* bear an especially rich mark of life, for attached to each spacecraft is a gold-plated copper record depicting the planet Earth and the life it holds. The record contains 118 pictures, encoded in sound just as a television image is encoded in electrical impulses. Diagrams engraved on the cover of the record instruct extraterrestrials on how to translate the sounds back into pictures. The pictures show the location of our sun in the galaxy, the nature of the sun and its family of planets, and various Earth landscapes and seascapes. They portray various forms of life, the form and function of DNA (the molecular blueprint of life contained in all cells), the human anatomy and life cycle, and diverse human activities, including food gathering, eating, working, athletics, the arts, and space flight. They show the kinds of buildings in which humans dwell, from huts to the Taj Mahal, and the machines we use, from cars to radio telescopes.

The record also carries an essay in sound that tells the story of evolution on Earth. The story begins with the primordial sounds of volcanoes, wind, thunderstorms, and the surf, the only sounds on Earth for ages. Then life announces its presence, and the voices of life grow more diverse and sophisticated. As the howlings of the wind and a wild dog evoke the wilderness from which we sprang, the footsteps and voices of humans are heard. A campfire crackles. Stones are struck against stones. A dog barks, now tamely, and sheep bleat.

Hammering and sawing announce human inventiveness. The sound of a horse and cart turns into the sounds of trains and airplanes, and then the roar of an Apollo moon rocket. An audio rendering of human brain waves fades into the signal of a pulsar, the whirling remnant of a star, thus symbolizing our discovery of the universe. And the record contains nearly 90 minutes of music, whose range from tribal folk songs to symphonies represents many cultural traditions. A similar diversity is heard in the greetings spoken in 55 human languages—and one whale language.

As one of the few people fortunate enough to have a copy of this recording, I can testify that it is a thoughtful and inspiring representation of our species and our planet.

Each *Voyager* is like a miniature Earth, loaded with landscapes and life and civilization. And each tiny Earth will voyage through enormous volumes of space, passing other planets believed to be circling other suns. In this respect also do the *Voyagers* remind me of the real Earth, for it too is on a great voyage.

Earth's voyage also began with a blast of fire, but this was a much grander ignition, some 15 billion years ago, called the Big Bang. The blast burned at trillions of degrees and sent all the matter in the universe flying rapidly outward. When the fire shut off, the motion did not—it would last for eons, perhaps forever.

The motion would not only last, it would elaborate itself into a huge variety of forms. During the fleeting moments of the Big Bang itself, the only motion was that of particles swarming and racing outward, yet from this chaos arose the graceful flow of electrons in atoms, stars in galaxies, and planets and moons in solar systems.

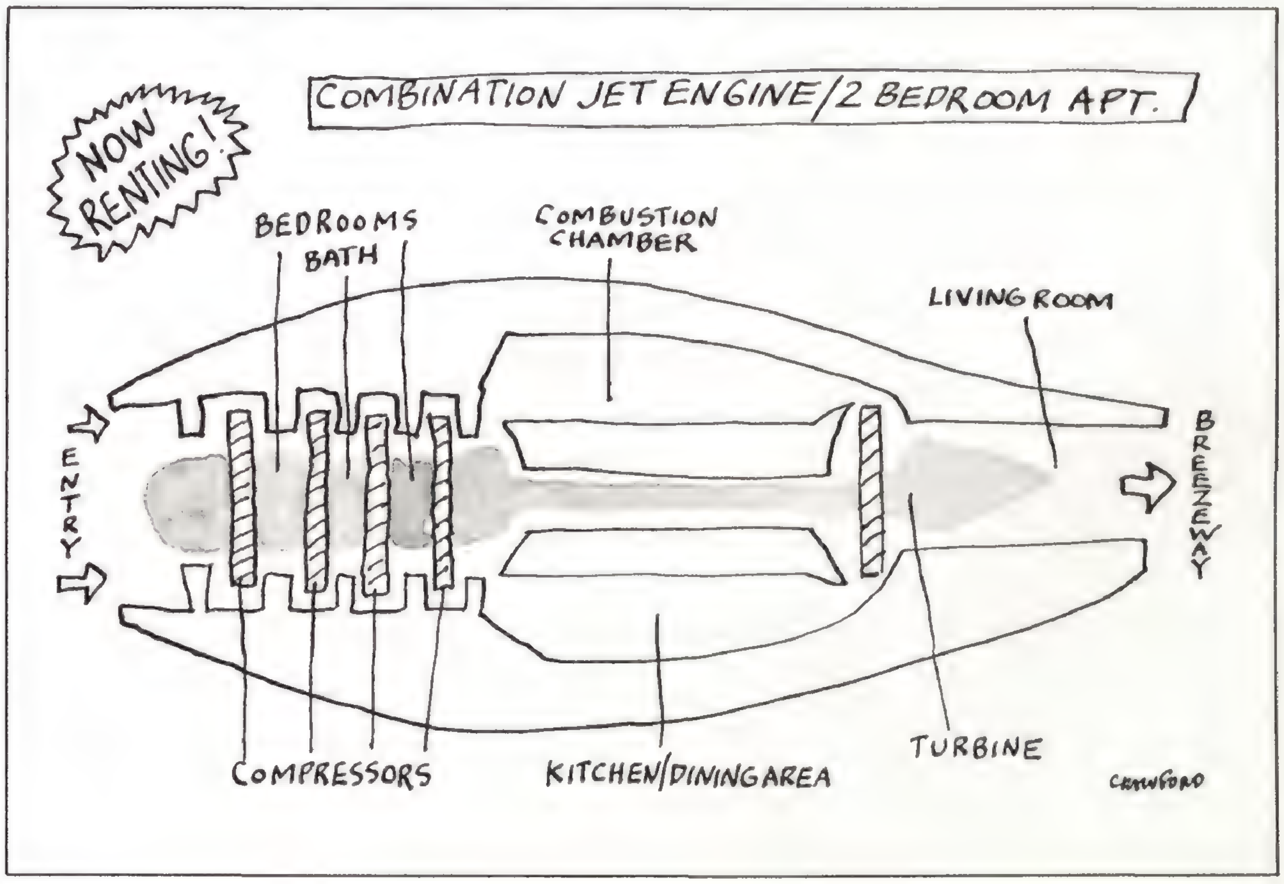
On one of the inner planets of one of the multitude of solar systems, the motion turned into volcanoes, drifting continents, oceans, winds, and rivers, and then it turned into an intricate flow of molecules called life. It turned into fish gliding through the water, birds soaring through the sky, plants raising their leaves to the morning sun, and animals roaming over the land. It turned into the footsteps and voices of humans, into elaborate vibrations of air called music, into dances and athletics, into a marvelous variety of mechanical wonders. It turned into the electrical waves pulsing in the human brain, and into the steady turning of a radio telescope tracking a pulsar. And it was ultimately transformed into the journey of two *Voyagers* heading for the outer planets to reveal to humans what the fierce motion that flew from the Big Bang had become there.

Earth's voyage outward from the Big Bang carries our planet through vast clouds of interstellar gas, past stray comets, and through the spiral arms of the Milky Way. As part of this galaxy, Earth drifts past other galaxies. Among all these crude forms and motions, Earth carries its precious cargo of far more sophisticated forms and motions. Earth is terribly alone on its voyage, perhaps the only piece of matter within hundreds of light-years where the energy stemming from the moment when time began has complicated itself into life.

But if the *Voyagers* are one day found, or, much more probably, if our radio telescopes find amid the formless energies flowing through space an energy signed by life, humans will no longer be so alone. We will discover that somewhere else the raw motion set loose in the universe has come to flow in the pattern of life and consciousness. I expect we will be shown what particular forms this life has taken, and through our radio telescopes we in turn will reveal what forms life has taken on Earth, as we tried to show with the golden record aboard the *Voyagers*.

It is our basic amazement at being what we are, this rare, strange thing called life, along with some of the fear and loneliness that comes as part of life, that motivates us to seek extraterrestrials. We and they are cast on a great voyage, not just a voyage through space but a 15 billion year voyage out of chaos. And our lives would be richer if shared with our fellow voyagers.

—*Don Lago*



# Icebound over the Atlantic

Illustrations by Guy Murchie

*To Guy Murchie, aviation holds fascinating possibilities for the keen observer. In his 1954 book,* Song of the Sky, *Murchie writes lovingly of the mundane and the sublime nature of flying. A newspaper correspondent until 1942, he joined American Airlines during the war as a navigator aboard a C-54. In the excerpt that follows, the author lyrically looks back on his role as a navigator and on his fellow crew members aboard one of these air freighters during a harrowing experience above the North Atlantic.*

She was built like a whale, for cargo and comfort. Ninety-four feet long and full-bellied, with wide tail flukes that could ease her nose up or down at the merest nudge of her controls.

Her sinews and nerves were four and a half miles of steel cable and insulated copper wire. Her brain was a set of instruments tended by radio waves, inertia, magnetic force, and atmospheric pressure, and all pivoted on sapphires and crystals.

She was Number 896, one of the original C-54s, the famous flying freighters designed especially for ocean transport—perhaps the most widely used long-range weight-carrying airplane to appear in the decades since man taught metal to fly.

On this night in February 1943 she floated confidently on a mantle of black air 11,000 feet deep and bottomed by the angry North Atlantic ocean. Her wings were of duralumin, styled to cut the sky at 240 mph. She rolled slightly—ever so slightly, like a porpoise sighing in sleep—just enough to tick the octant bubble from Mizar by the pole.

Inside her lighted bulk the air was 20 inches of mercury, or only two thirds the density of sea level. The temperature was 75 degrees Fahrenheit where her crew sat in the cockpit, 52 degrees in the fuel compartment amidships, and 8 degrees below zero outside. Her four motors, representing the heft of 5,400 horses, breathed the thin cold air with the aid of superchargers forcing the vital oxygen into their pipes at a manifold pressure of 31 inches.

Her gross weight at the moment was 62,180 pounds—6,200 pounds of it cargo, priority 1A, battened by rope and steel rods to the cabin floor: penicillin from Chas. Pfizer & Co., New York City, destined for London, England, and oxygen cylinders, type F-2, from Firestone Steel Products, Akron, Ohio, marked for Burtonwood, England. She had taken off from Stephenville, Newfoundland, amid snow flurries in the late afternoon. She was bound for Prestwick, Scotland, 2,296 miles away by the great circle.

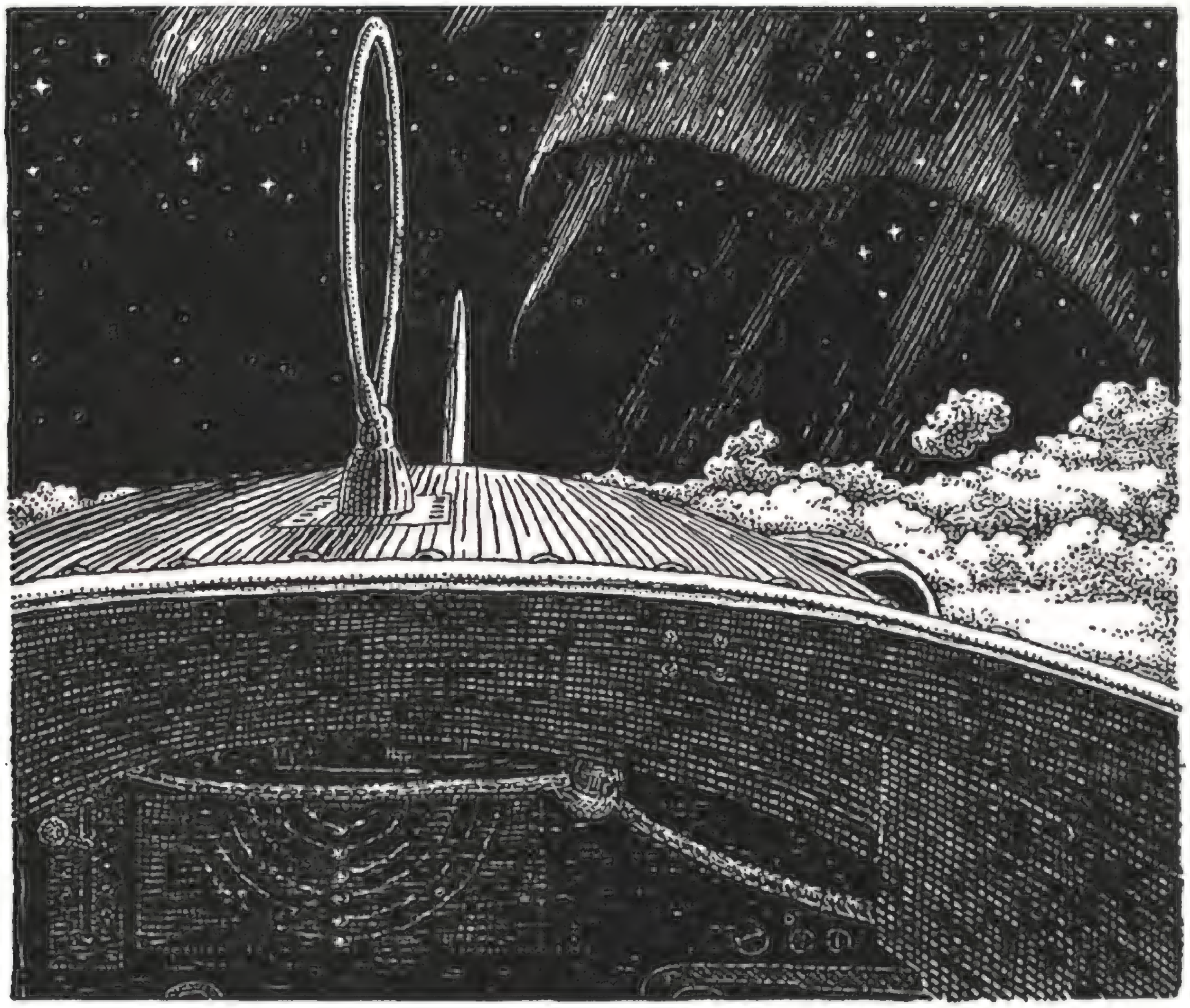
We men of the crew sat at our stations, going through our motions, writing words and figures into flight logs, occasionally dreaming, or talking, or unbuttoning a little with caprice. From the flight deck we could not see the waves two miles below. There were dense clouds covering the sea and the sun was deep under the earth. In the western sky Orion and the gibbous moon swung downward at 15 degrees per hour. And as the earth turned and the planets turned, the galaxy of the Milky Way moved on its inscrutable course through the black universe of which man knows not the beginning nor the end.

"What are you doing up here? Why is that octant in your hand?"

It could have been the wind asking. I was the navigator seated at my chart table in the airplane's cockpit, gazing into the darkness beyond the window. The wind—a wind which never existed before the airplane—was crying in long monosyllables like a Chinese bird-monger. "Why—wh-h-y—wh-wh-h-h-h-h-y-y-y?" It sprang full-born from the Plexiglas nose and exploded upon the duralumin skin, sprawling backward over the humps of the astrodome and the engines, tearing itself cruelly on each protruding edge of cowling, each pitot and spar. It was the invisible substance of which the sky is made—not just air, not just wind, but a stuff which is part of the insoluble consciousness of flight.

"Why is that octant in your hand?"

Because I am the navigator. I hold the



needle that will pierce the cloud. I sing the song of the sky.

While flying the ocean I am plainly the busiest of our crew of five. I keep account of the airplane's position and track over the earth, of altitude and the passing cloud layers, of horsepower and consumption of fuel. My flight log sometimes contains scores of entries in a single hour. I work with wind, radio waves, sun and stars, with charts of many colors, with tables heavy in figures. My hands know tools of precise design. My mind is as a detective in the crime laboratory, sifting and weighing the clues of drift and speed. I winnow the meager facts, seeking to construct truth only from the clean kernels. I am a human lodestone—the homing pigeon of mankind.

Frequently I converse with the pilot who likes to know where we are, how long before we will get to such and such a place ahead on the map, or how much gas is left in our tanks. Pilot on this flight is Captain Blake Cloud, who sits up front in the driver's seat, a wiry little man with pale brown eyes that blink nervously from behind his oxygen mask. He is the ranking officer of this Douglas-built C-54, this oceanwise dragon of the air.

Second in our hierarchy is Gullerman Dropford, the copilot or first officer who sits on Cloud's right with a duplicate set of controls. He graduated from Yale and appears to veer to the conservative.

I am third in command, followed in rank by Ernie Silvers, flight radio officer, an ovate Lothario whose desk is opposite mine in the cockpit, and Ignatz Wuzienski, flight engineer, a gangling Texas lad who sleeps most of the time between his few routine check duties while in the air.

We are all serving as employees of American Airlines in this first regular transoceanic round-the-clock freight service that the world has ever seen. This daring transportation project was to web the earth with traffic routes of a swiftness and efficiency that would amaze friend and foe alike. We sense our place in history as pioneers of a great age of air transport that will defy time and space and weather and future dangers of extreme speed and altitude of which we have hardly yet begun to learn.

I put the octant back into its case and glanced at my airspeed indicator. The needle pointed to 166 knots [191 mph]. My thermometer read six degrees below. The altitude was 11,000. Magic needles quivering before me—needles of light in the darkness. Adjusting my slide rule computer in a familiar calculation, I read off our corrected or true airspeed: 184 knots [211 mph]—a difference which is one of the navigator's first lessons in the air, a difference accounted for by the limitations of instruments in this pioneer era of navigation. Instruments can measure airspeed pretty accurately at a constant altitude and temperature but the varying altitudes and temperatures of actual flying cause errors which no improvement of the instrument has so far been able to overcome. After this, I'll also check our fuel supply and altitude, among other duties.

The substance that is the sky still swallowed us in its roar as Number 896 continued on her course. In my reverie I wondered if it could make any difference whether we moved while the air stood still or the air moved while we stood still.

Jotting down the airspeed in my flight log, I glanced next at the fuel-flow meters on the main panel to see the rate of gas consumption. Again by some familiar figuring I found the true hourly rate and recorded it.

Then for exact altitude I had to correct the altimeter needle reading for barometric pressure and temperature, working it out on my computer: 10,850 feet. Scores of times on every flight these same corrections have to be understood and reckoned. And many others like them. It is a part of life, a sort of compensation for the untamed inexactitude of nature.

As I watched, Blake Cloud stirred from a

brief slumber, rubbed his eyes, and ran his fingers through his hair. He put on his oxygen mask again. Extra oxygen is not essential at 11,000 feet, but a little now and then will help keep a man from sleepiness.

"Wonder how long this snow's gonna keep up," said Blake, indicating the windshield with his flashlight where a crust of freezing slush was collecting as fast as the wipers could take it.

"Probably just a local storm," I said, "but anything is possible from the forecast."

"What about the wind for twenty-four hundred? [hours]" he asked.

I looked at my log. "One-twenty at thirty knots [36 mph]. That was a between-fix wind." (120 degrees at 30 knots is a fairly strong southeast wind.)

Just as I had turned back to my desk and started to plot another section of my fuel-consumption graph, I heard the captain call out: "Somebody wake Woozy! We're taking on ice and the de-icers aren't working."

Wuzienski was asleep in the upper bunk of the crewroom. I stepped in there and poked the prostrate form.

"Woozy! Better get up. The skipper says we're taking on ice and the de-icers are on the fritz."

"Okay, okay."

He scrambled to the linoleum floor, all six feet two of him, rubbed his blond mop of hair, shook his coverall straight, and walked the ten feet to where the captain sat.

"Look!" said Blake Cloud. He picked up the Aldis lamp, which is something like a car headlight with a handle and a trigger, and flashed its brilliant beam out the window. Woozy and I could see the forward edge of the wing glistening white where the light struck it. The ice was already two inches thick. The air was dense with supercooled rain which streaked horizontally against the wing, the engine nacelles, and the aerial spars, rapidly forming ice.

"What's the matter with the de-icers?" asked the captain, looking at Woozy. "The switches are on but the pressure gauge reads zero."

"Don't know, sir. I'll check the fuses." Wuzienski stepped back and opened the fuse-box door behind where Silvers sat.

"Look at that airspeed," said Cloud. "God, a hundred thirty-five on the instrument. If this keeps up we'll be stalling in ten minutes. What d'you find, Woozy?"

Woozy shut the fuse box and stepped forward. "Fuses okay, sir. The trouble might be in the wiring somewhere, or the air line might have a leak."

"We're gonna get out o' here," said Blake Cloud. His jaw was tight as he pulled back gently on the wheel and adjusted the four throttle knobs. "We're goin' upstairs."

The motors took on a deeper roar, seeming to change from a major to a minor chord as the plane began a steep climb. That sinister harmony of the four great engines may have been a reflection of the crew's anxiety as we realized the growing seriousness of our burden of ice. It was a weird hum that seemed to throb through my brain with every heartbeat.

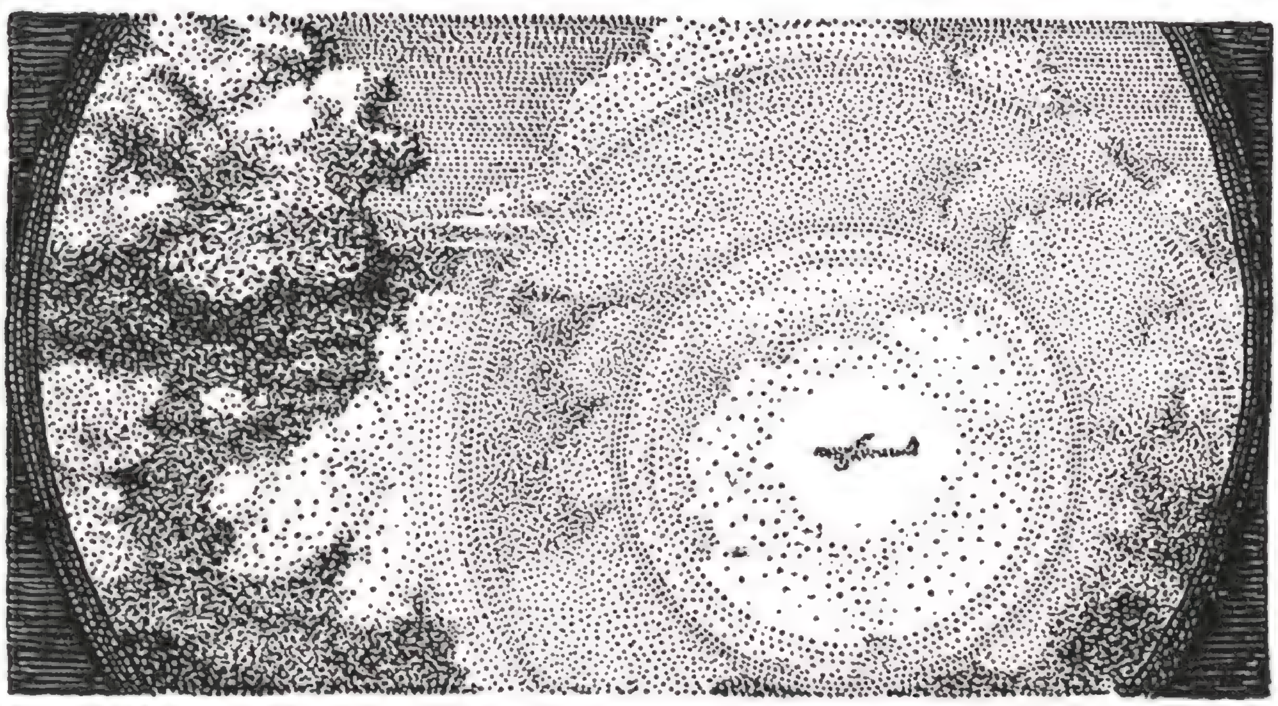
I watched the airspeed indicators: 125 . . . 123 . . . 120. . . . It was natural for the airspeed to decrease in starting a climb, but it shouldn't be nearly that low with the increased horsepower, and it shouldn't keep on decreasing. Blake Cloud flashed the Aldis lamp on the wing every minute or so. By the time we got to 12,000 feet there was more than three inches of ice and it was getting ragged and irregular in form. The whole airplane had begun to vibrate strangely.

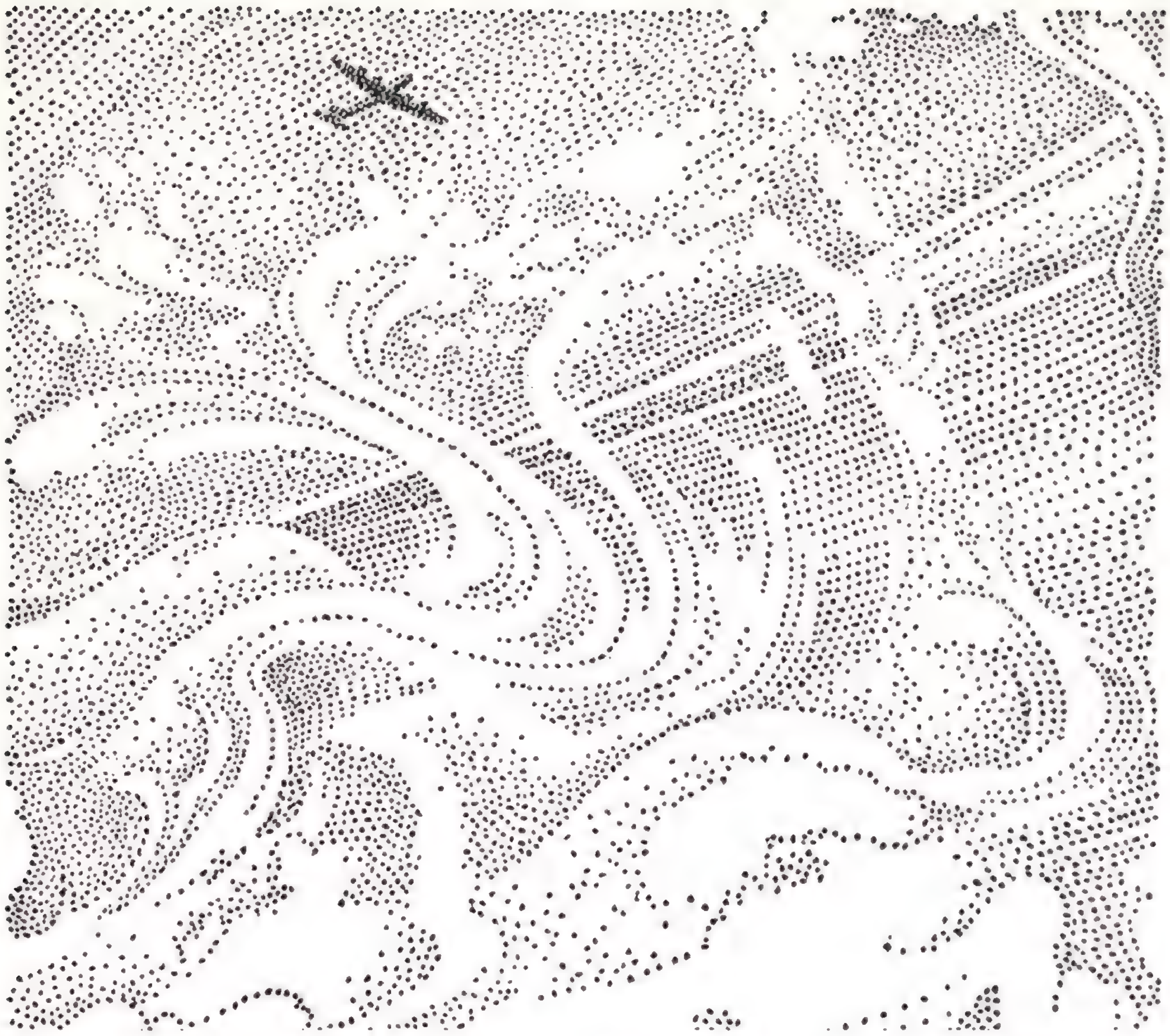
The altimeter needle crept slowly upward—more slowly than at first. The airspeed continued to fall. The airspeed was hardly enough to permit the plane to continue climbing. The needle pointed to 116.

"Suffering Christ!" said Cloud. He turned around in his seat. "Woozy, have you found what's wrong?"

"No sir. The boots just don't go. Must be a leak somewhere."

The gross weight of the airplane was in-





creasing as the ice added to it. But more serious was the fact that the ice was changing the airfoil, changing it from the smooth curve the Douglas engineers had designed into an irregular blunt shape that threw eddies into the slip stream, destroying the air pressure components that gave the wing its lift. As the wing lost lift Blake Cloud had to hold the wheel further back, bringing the airplane's nose higher, in order to keep flying. This adjustment temporarily restored the wing's lift but it also reduced airspeed, bringing it ever nearer the airplane's stalling speed, somewhere close to 100 mph, at which it would start to mush or lose altitude no matter how much its nose might be inclined upward. If the ice kept on accumulating, the plane would sink lower and lower until eventually it would fall into the sea like a pigeon dipped in plaster.

"Say, let me see that weather folder again," called the captain suddenly. "If we don't top this stuff damned soon our only choice will be to get under it or find a space between layers. We can't thaw the ice off. The temperature is below freezing all the way down."

He grabbed the paper, unfolded it, and scrutinized the cross-section drawing of forecast cloud layers done in green and pink by the weather office in Stephenville.

"God," he muttered. "There's liable to be clouds clear to the drink according to this. I can't count on coming out with all the stuff they got on here. But, of course, this thing may be all wet. It's 12 hours old. I think I'll top this stuff if I can."

He flashed the lamp once more against the wing. The ice was bulging forward from the airfoil in angry corrugations—in some places four or five inches thick. The airspeed indicator read 112. And still the rain streaked mercilessly against us, and we labored upward foot by foot—a creature of the air, a delicate creature of all our 62,000 pounds—a flying whale built by man—man who had dared that which even the birds could not do.

Suddenly I felt a jerk. The whole airplane lunged sickeningly. So this is it? We are going into a spin. It will be quicker than I thought.

I'd better figure our position for the SOS. My watch says 00.49. Latitude? . . . Longitude? . . . An SOS in the North Atlantic on a February night is about as practical as digging for water on the Sahara. I felt empty.

Then I noticed the airspeed: 115. Isn't that faster than before? I felt Cloud goosing the motors. The plane heaved itself forward, jerking violently several more times.

"They're working!" shouted the captain. "The de-icers are working!" He flashed the lamp on the wing and I could see that large sections of the ice had already been pried off by the pulsating boots.

Woozy grinned from the fuse box. Black smooches covered his face. "I did it," he announced with mock conceit. "When you need anything in engineering, just send for me."

"What was it?" I asked.

"The fuse," he said. "I had a brain wave and stuck a new one in. Old one looks okay but it must be haywire. No trouble. No trouble at all."

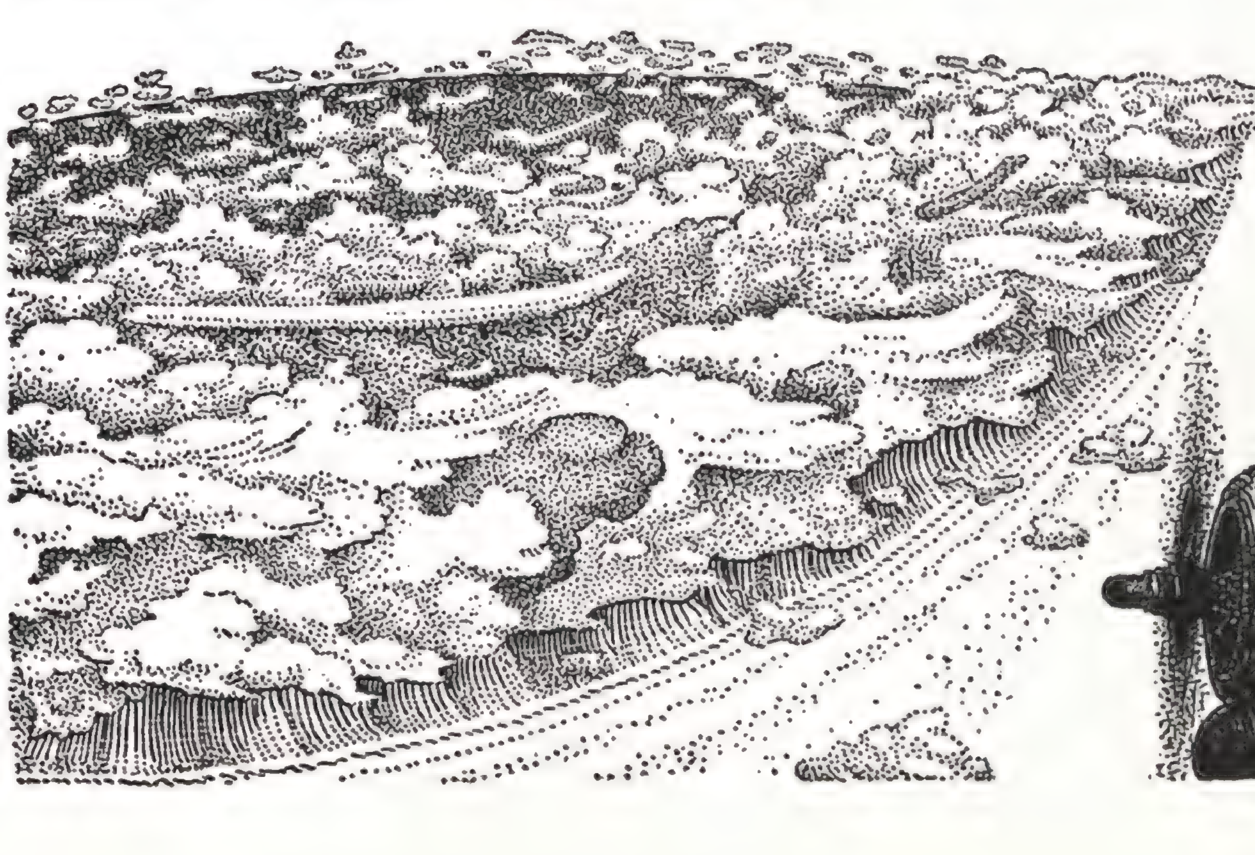
A few minutes later, as if in response to our feelings, little lights suddenly appeared outside the windows. Stars!

We had emerged from our shroud of doom. Number 896 had thrown off all her clothes: her white underwear of ice, her white overcoat of cloud. Regulus and the Big Dipper were almost grinning at us.

"No trouble at all," Woozy had said. All part of life.

Problems . . . problems. You take them in your stride as part of the day's work and you keep going—flying—flying over the sea, flying through the clouds—under the winking stars.

Excerpted from *Song of the Sky*; copyright by Guy Murchie. Published by Houghton Mifflin and reprinted by arrangement with the author.



**The Cutting Edge.** *By C.J. Heatley III. Foreword by Senator Jake Garn. Thomasson-Grant, 1986. 152 pp., color photographs, $38 (hardbound).*

*The Cutting Edge* will probably fall into that genre known as "coffee-table books," which is unfortunate. Most aviation coffee-table books feature rather mediocre photography and text right out of *Jane's All the World's Aircraft.* Such is not the case with this magnificent photoessay on modern carrier aviation. It is quite possibly the best collection of contemporary aviation photography yet to be published.

Publishers Thomasson-Grant already have a highly successful picture book on the U.S. Air Force, *Wings,* to their credit. C.J. Heatley—amateur photojournalist and professional U.S. Navy fighter pilot—was the logical choice as the photographer-author of a complement to *Wings.* Lieutenant Commander "Heater" Heatley ("Even my wife calls me 'Heater' ") already had a reputation within the naval aviation community in southern California as a superb photographer with a rare ability to capture the essence and excitement of life aboard an aircraft carrier. Over the past five years, while flying F-14 Tomcats from the carriers *Kitty Hawk* and *Ranger* in the Pacific, Heatley has managed to accumulate more than 20,000 images of people, aircraft, and ships involved in sea-air operations.

U.S. Naval aviation celebrates its 75th anniversary in 1986, and it is fitting that some of Heatley's best photographs are included in this tribute to those who have flown on what Heatley calls "the cutting edge." The entire gamut of flight operations at sea is covered in this extravagant collection. Heatley, an artist with a wonderful appreciation for composition, uses clouds dramatically as the backdrop for his scenes of various carrier aircraft going through their paces.

Of greatest importance, however, is Heatley's compelling use of those elements of naval aviation which make it as different from U.S. Air Force aviation as *The Cutting Edge* is from *Wings*—the sea; the carrier, or the "boat" as it is known; and the

Photos by C.J. Heatley

*After 75 years, naval aviation bears little resemblance to its beginnings. From* The Cutting Edge *come these images: a tail gunner in a Soviet Bear (top), the "boat" (above), and an F-14A (above right).*

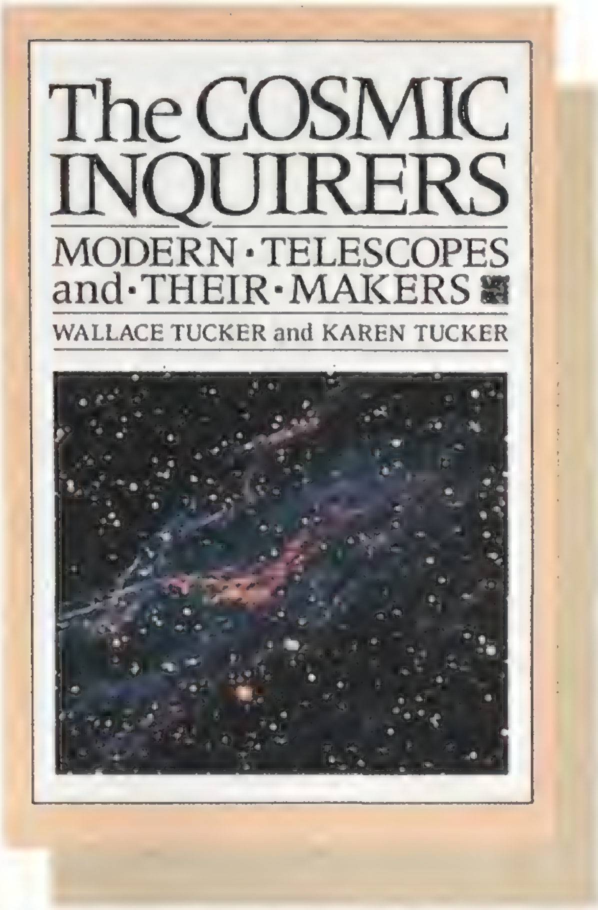
boat's escorts. All the dynamic operations of everyday life on a long cruise at sea are here. On the flight deck, crewmen in their multi-colored jerseys perform a ritualistic ballet as they catapult aircraft off the bow and recover returning jets at the stern. The photographs vividly illustrate a flight-deck petty officer's description of life in that very unfriendly place: "You can be sucked up, run over, blown over, and knocked down."

Heatley dedicates a special section of his book to night operations. Carrier aviators remember their flying careers in terms of carrier landings rather than flight hours. Night carrier landings become the real measure of a pilot's airmanship, perseverance, courage, and—to some degree—luck. It is axiomatic that every carrier aviator inevitably will have his "turn in the barrel": a black night in the middle of the ocean with low ceiling, low visibility, a night of missed approaches, of going around and around the traffic pattern. Often fuel, skill, and physical and mental reserves all run dry at about the same time. An A-7 pilot puts it well: "You find yourself promising God that you'll be good!" Heatley's photos of night operations are dreamlike, bizarre scenes from another world: a Tomcat turns up on the catapult in full afterburner, lighting up the flight deck in an eerie glow, revealing the catapult crew crouching in the darkness, the catapult officer waving his lighted wand as he sends the aircraft off into the night. At the other end of the flight deck, another F-14 crosses the fantail in a blur of wing lights, slams onto the deck, and snatches an arresting wire. Heatley's images of night flight, coupled with his very moving anecdote in the introduction about a shipmate and good friend having his "night in the barrel," come remarkably close to telling the whole story of night flying from the ship.

Most of the text takes the form of interviews with pilots, officers, and other carrier personnel. This text adequately complements the superb photographs. Readers will gain an excellent understanding and appreciation of the missions and capabilities of the many different types of carrier aircraft, the attitudes and emotions of the people who fly and maintain them, and the vital roles played by the ship's crew. But the interviews are rather bland, a bit too understated. There are enough one-liners sprinkled throughout the book to remind you of where you are (an A-6 Intruder pilot, for example, describing a catapult shot: "You either fly or get dumped in the water") and the intrinsic ability of military pilots to look back at the dangers of their profession with a touch of humor shines through, but overall the text is not as colorful as the photographs.

Senator Jake Garn, a former naval aviator, pays tribute to 75 years of U.S. naval aviation in his foreword, and makes the point that while technology has wrought incredible changes in carrier aviation since the 1950s, the people have not changed. He might also agree that even with equipment infinitely more sophisticated and pilots more extensively trained, one fundamental problem has not changed: a carrier pilot still has to get his airplane off and on the ship, routinely, day and night, in fair weather and foul. "Heater" Heatley documents this for us in dramatic fashion, putting the reader in the cockpit and on the flight deck better than any other aviation photographer has done before.

*—E. T. Wooldridge served in the U.S. Navy for 26 years. He is now chairman of the Aeronautics Department at the National Air and Space Museum.*




*The Cosmic Inquirers probes the politics behind modern astronomy.*

**The Cosmic Inquirers: Modern Telescopes and Their Makers.** *By Wallace Tucker and Karen Tucker. Harvard University Press, 1986. 221 pp., B&W photographs, $20 (hardbound).*

There was a time when astronomers made their discoveries by crouching over telescopes, or by painstakingly comparing photographic plates taken through optical lenses. There was also a time when people believed the Earth was the center of the universe. This, too, has passed.

Today, earthbound optical astronomy is being overshadowed by x-ray, gamma ray, infrared, ultraviolet, and space-based observations. And, as Wallace Tucker and Karen Tucker demonstrate in *The Cosmic Inquirers,* the political battles waged to ensure funding for astronomical research become more intense as observations and experiments require more advanced and expensive equipment.

Galileo had his problems with the Church. Today's pioneering astrophysicists find they have to worry more about the State. Physicist John Bahcall, who joined the Edwin P. Hubble Space Telescope project as one of a 12-member working group, eventually found that half of his time was spent lobbying for funding, not solving technical problems. To obtain money for the $1.2 billion-plus Space Telescope (to be launched into orbit via space shuttle), Bahcall and his colleagues had to twist the proper arms in NASA and Congress. They also had the difficult task of convincing members of a divided astronomical community, each with his own pet project, to rally behind the Space Telescope.

Unfortunately, the political and scientific struggles recorded in *The Cosmic Inquirers* will be of interest mainly to closet bureaucrats and members of the scientific community. The text is too dense and too jargon-ridden to be of interest—or even intelligible—to the layman. Consider, for example, the following passage: "[Frank] Low was more explicit. 'They [the MOSFETs, or metal oxide semiconductor field effect transistors] were not only unreliable but they were also unstable and noisy.' He wanted to use a different type of transistor for amplification called a JFET, for junction field effect transistor. 'We recognized here [at the University of Arizona] early on the deficiencies of MOSFETs and tried to pursue the JFETs.' "

Important as these decisions were, they do not hold much interest for the general reader, especially when compared to the astronomical discoveries mentioned in passing. It's a rare reader indeed who cares more about MOSFETs and congressional funding than black holes, anti-matter galaxies, and x-ray stars.

*The Cosmic Inquirers* does attempt to address an interesting question: who are today's astronomers, and how do they get their projects off the ground? Unfortunately, the book itself usually remains steadfastly earthbound, and takes flight only when it touches the stars.

*—Tom Huntington*

**An Astronaut's Diary.** *By Jeffrey A. Hoffman. Caliban Press, 1986. 43 pp., $6.95 (paperback), $8.95 (paperback and cassette tape). Available by order from Caliban Press, 114 Westview Road, Montclair, New Jersey, 07043.*

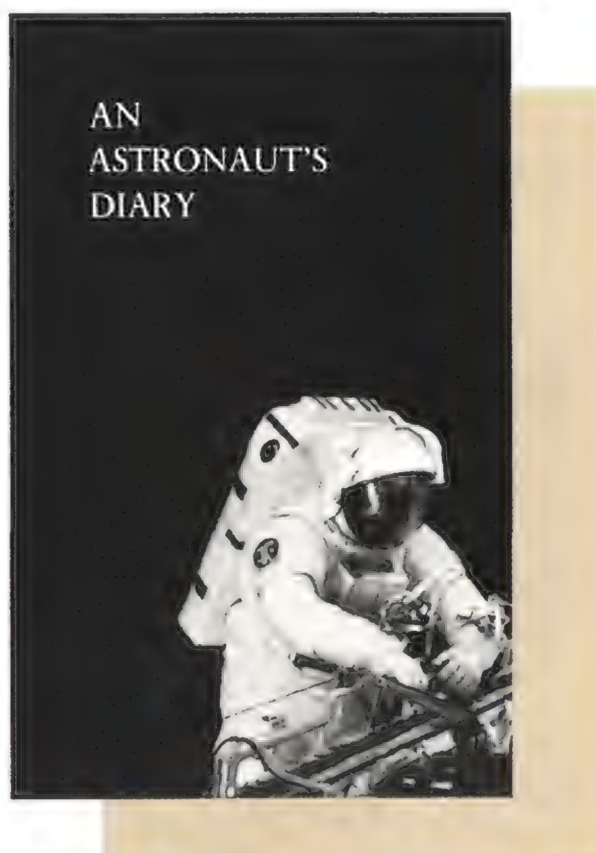
America loves her astronauts. They are the heroes we dream of being, the symbols of a future our children will one day see. We are living on the edge of a time when space travel will become available to all people, and as one who believes that life's possibilities expand with the boundaries of our awareness, I can't wait for that day to come. I was privileged this year to be among the 100 journalists in contention to fly on the space shuttle. From that perspective, I read astronaut Jeffrey Hoffman's book with great anticipation, hoping to get a feel for what daily life outside the Earth's atmosphere is like. Unfortunately, I was disappointed with both the content and presentation of *An Astronaut's Diary.*

Hoffman gives tantalizing glimpses of his first flight aboard the space shuttle *Discovery* in April 1985, but his account reads like the outline of a book report. As an active member of the shuttle crew, he had duties to perform which rightly took precedence over keeping a diary, and it is understandable that his perspective as an astronaut differs from that of a journalist. But perhaps it would have been better if he had fleshed out his story before publishing it.

His description of the gravitational force experienced at lift-off, for example, consists of "a continuous feeling of pitching backward." I wanted to read so much more. I wanted him to tell me that an invisible hand pushes your body slowly back into the seat as the skin on your face is stretched against the bones, and that if you close your eyes for one minute, you feel both totally alone and completely at one with the vast universe. I offer this brief description because I've had the opportunity to experience a simulated shuttle launch and believe it evoked only an inkling of the real thing.

Details are missing throughout the diary. He relates the crew's daily menus, but doesn't say how the food is cooked or eaten in weightlessness. He hints that while brushing your teeth in space it it advisable to keep your mouth shut. But can you squeeze the tube without the toothpaste floating away? And does *everyone* get lower back pain from sleeping in weightlessness?

I particularly wanted to read more about the relationship between crew members.




*Jeffrey Hoffman takes readers along on a space-shuttle mission.*

Hoffman describes the activities—and dangers—he shares with his fellow astronauts, but the closeness that must exist between people whose lives depend on each other does not come through. Since I hope to live long enough to go into space myself, I'd love to know more about people who have been there already.

There is much Hoffman could share about his experiences that would make rich reading. Mixed in among the "space-talk" jargon in this book is a playful sense of humor and true reverence for space travel. I smiled at the image of him and payload specialist Charlie Walker blowing lemonade drops toward each other in mid-deck. And I resonated with his reading of a poem that touches on why humans reach for the stars—for the person who lives in a valley cannot know what life is like on the top of a mountain, but if he climbs its heights, he will know both what is above and what is below. Surely that is why man has always dreamed of having wings.

Hoffman's diary was originally kept on a cassette tape recorder. An edited version of his tape, which lends immediacy to the story, is available with the book.

The story of space is a story of hope, a story filled with the promise of tomorrow. Hoffman dedicates his book to the lost *Challenger* crew. As Hoffman explains, "The reason for publishing this diary is to help make the experience of space flight more understandable to all the people on the earth who wonder what astronauts really do up there. The loss of the *Challenger* Seven makes it even more important to understand." I couldn't agree with him more. I also agree wholeheartedly that there is still much work to be done up there. Sometimes the news seems dominated by stories of mishaps, ineptitudes, and malice, and now that bad news includes disasters in space. But when astronauts once again go into space, and when ordinary citizens one day join them, they will bring home a message of wonder and of hope.

*—Dinah Eng is a reporter for the* Detroit News. *She was selected as one of the 100 semifinalists in the Journalist-in-Space competition.*

**Stormy Genius: The Life of Aviation's Maverick Bill Lear.** *By Richard Rashke. Houghton Mifflin Company, 1985. 401 pp., B&W photographs, $19.95 (hardbound).*

"The thing that I love to do more than anything else is to fly," Bill Lear affirmed just a few years before his 1978 death. "When I'm really all wrought up and think that there's no end—you know, never find a solution to something—I get in my Learjet and go up and do a few rolls—if the FAA doesn't find out about it! I get all relaxed and then I can start again." That quotation is about as self-revealing as Lear ever got. It's also, alas, about as close to understanding this complex man—his obsessional love of flying, his rebellion against authority—as readers of the biography *Stormy Genius* are likely to get. What readers do get, in rich abundance, is a colorfully detailed and action-packed story about a high-flying life.

Born in 1902 to poor and troubled parents, William Powell Lear grew up to personify the heroes of rags-to-riches Horatio Alger stories. The young Willy himself had read most of these stories by the time he was a teenage grease monkey servicing the "flaming coffins" of the Aerial Mail Service at Chicago's Grant Park in 1919. From the humblest of beginnings, this tinkerer and dreamer designed and invented his way into competitive niches that made him millions. He often in turn lost these millions, only to start all over again and make more millions. And these uniquely individual achievements occurred on the leading edge of the two industries that in many ways define the twentieth century: aviation and electronics. Bill Lear's creations include: the first practical direction finder for airplanes; the first automatic pilot for jets; an automatic landing system for jets; the eight-track tape; and, ironically (given his anti-corporate mentality), the corporate jet that bears his name.

But this archetypical entrepreneur, long before such a description would have been fashionable, had what even the kindest critic would have to call a darkly complex personality. His creative genius on a professional level was more than matched by destructive demons on a personal level, as evidenced by his broken marriages, strings of mistresses and girlfriends, estranged children, and associates whose loyalty he often repaid with humiliation.

Unfortunately, this catalogue of symptoms is about as far as the biographer goes in illuminating Lear's psychology; and after 400-plus pages, frustrated readers can only infer that the same psychological forces, in particular his peculiar relationship with his mother, that drove Bill Lear professionally must also have had something to do with his less than noble personal behavior.

Indeed, biographer Richard Rashke (who also authored *The Killing of Karen Silkwood*) in effect warns readers of his limited intentions in observing that Lear's last wife Moya "found it difficult to understand how he could be so brilliant, creative, and self-confident, yet so driven and insecure. In the end, she stopped trying to figure it out and just accepted him." And that's clearly what Rashke did, too.

If you like biographies that are crisp, clean, and chronological, this well-researched and well-written work should more than qualify as a "good read." *Stormy Genius* would be more appealing, however, if Rashke had taken an entrepreneur-like risk or two himself in trying to fathom the psychology of his entrepreneurial subject.

*—Walter Nicklin is a publishing consultant based in Arlington, Virginia.*


*"This shouldn't happen, should it—three days out of orbit, and still weightless?"*


Thurs.

Fri.

# The week we looked terrorism in the eye and proposed a way to make it blink.

Its face has grown familiar. In the endless images of twisted wreckage and shattered bodies left scattered in its wake.

It claims to work for many causes, but wields only one tool—violence. And its target is you. Your family, your children, your life.

The face of terrorism. It's become a major force in our world, and Newsweek has detailed its violent development. But we didn't stop there. Because when Newsweek looks at a story, we see beyond the face of it.

Beyond the problems, or the situations, or even the motivations—we see and search for solutions. Recently, we proposed 10 concrete steps designed to combat terrorism. Among them: improved intelligence gathering, cracking down on unsafe airports and greater pressure on terrorist allies.


Wed.
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# Credits & Further Reading

**Space Plane.** *Peter Gwynne* is the senior editor covering military and aerospace affairs for *High Technology* magazine in Boston. He has covered space flight since the *Apollo 7* flight.
*Further Information: Pioneering the Space Frontier: The Report of the National Commission on Space* (Bantam Books, New York, 1986).

**Ghostwriters in the Sky.** A west coast freelance writer, *Dennis Meredith* is also director of the news bureau at the California Institute of Technology. While researching skytyping, he discovered that notes taken at 10,000 feet without oxygen are indecipherable.
*Further Information:* "Up in Smoke" by Berl Brechner in *Flying*, Vol. 110, No. 1, January 1983.

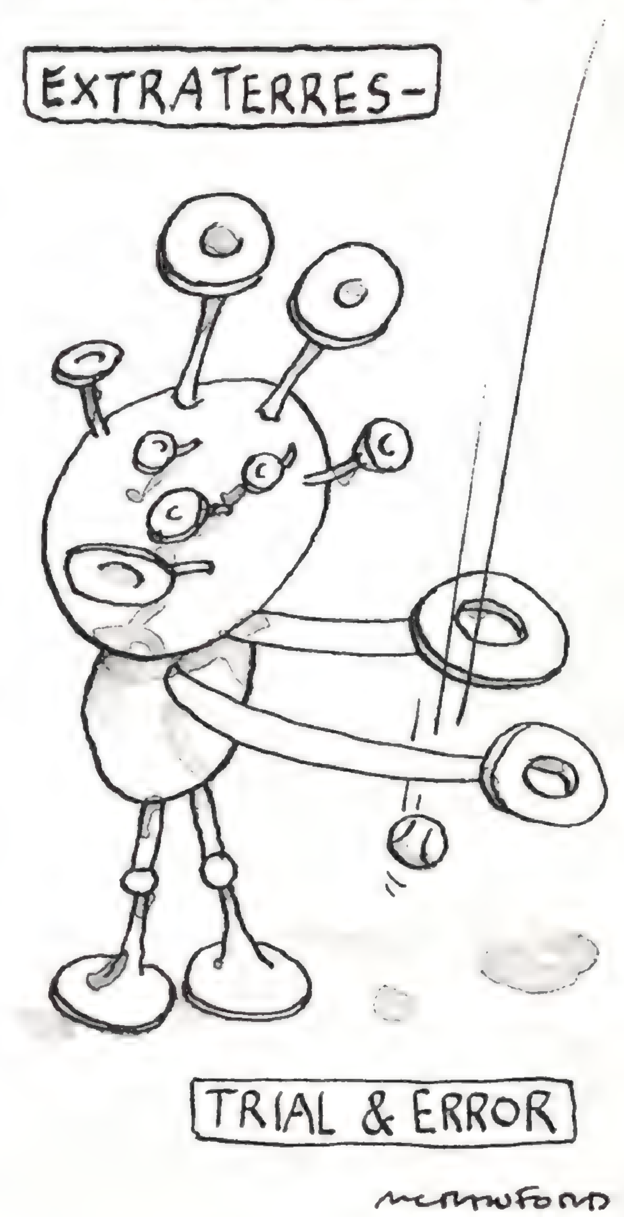
**The Might of the Microburst.** *Henry Lansford,* a freelance writer and communications consultant, lives in Boulder, Colorado. His work has appeared in a variety of publications, from scientific journals to Sunday supplements.
*Further Information: Severe Weather Flying* by Dennis W. Newton (McGraw Hill, New York, 1983).
*Sciences and Climate* (National Academy Press, Washington, D.C., 1983).

**Wind Shear: A Pilot's View.** *Thomas Foxworth* has 22 years of experience as a pilot for a major airline, and is the co-author of the novel *Passengers* (Doubleday). He has a long involvement in aviation safety activities.

**Rekindling Our Dreams.** The Honorable *Ernest Hollings* is Senator from South Carolina and the ranking Democrat on the Senate Committee on Commerce, Science, and Transportation.
*Further Information: Pioneering the Space Frontier: The Report of the National Commission on Space* (Bantam Books, New York, 1986).

**Star Patrol.** An amateur astronomer, *John W. Briggs* is working on comet research at the University of Denver while attending the University of Colorado.
*Further Information: The Amateur Astronomer's Handbook* by James Muirden (Harper and Row, New York, 1983).
*Burnham's Celestial Guide* by Robert Burnham (Dover Publications, Inc., New York, 1978).
To contact the American Association of Variable Star Observers, write to 25 Birch St., Cambridge, Mass., 02138.

**Wings and a Prayer.** *John Henahan* is a freelance writer specializing in science and medicine. He works primarily in Europe and has lived in Ireland for the past seven years.
*Further Information: Rambling in the West of Ireland* by William Bulfin (Irish



Book Center, Dublin, 1979).

**The Cars Won't Fly.** *Robert C. Post* is the editor of *Technology and Culture* in Washington, D.C. He used to race dragsters, but now drives a sedate seven-year-old Volvo.
*Further Information: History of Drag Racing* by the editors of *Hot Rod Magazine* (Petersen Publishing, Los Angeles, 1981).

**Celestial Visions.** *Mike McIntyre* lives in Washington, D.C., where he writes a weekly theater column for *The Washington Post.*
*Further Information: The Conquest of Space* by Willy Ley, paintings by Chesley Bonestell (Viking Press, New York, 1949).
*Mars* by Robert Shirley Richardson, illustrations by Chesley Bonestell (Harcourt, Brace, and World, New York, 1964).
*Beyond Jupiter: The Worlds of Tomorrow.* Illustrations by Chesley Bonestell, text by Arthur C. Clarke (Little, Brown, and Co., Boston, 1972).

**New Guinea's Great Aerial Gold Rush.** *Terry Gwynn-Jones'* books include *Heroic Australian Air Stories, Air Racers: Aviation's Golden Era,* and *Aviation's Magnificent Gamblers.* In 1975, he and Denys Dalton set a speed record for a trip around the world in a piston-engine airplane. Gwynn-Jones lives in Brisbane, Australia.
*Further Information: Wings of Gold* by James Sinclair (Pacific Publications, Sydney, 1978).
*The Wandering Years* by Arthur H. Affleck (Longmands, Melbourne, 1964).

**Hurricane Busters.** *Otha C. Spencer* is a retired professor of journalism and photography from East Texas State University, and has experience as an Army Air Force pilot. His publications include five books on photography and numerous magazine articles. He lives in Campbell, Texas.

**Featherwaste.** *Edwards Park* was one of the founding editors of *Smithsonian* magazine. He has discovered that the phrase "eats like a bird" can be misleading, too.

**Seeking Our Fellow Voyagers.** *Don Lago*'s science essays have appeared in *Astronomy, Science Digest,* and other publications. A native of planet Earth, he plans to continue living here. His residence is in Columbia, Missouri.
*Further Information: Murmurs of Earth: The Voyager Interstellar Record* by Carl Sagan, et al (Random House, New York, 1978).

# Upcoming Features Just Over the Horizon

Mi Seitelman

Berl Brechner

**The Electric Jet**—The F-16 Fighting Falcon achieves its renowned maneuverability by design: it was deliberately built to be unstable. Computers provide this agile fighter with electronic "artificial stability," a development that paves the way toward more efficient airplanes of all kinds.

**Expo Air**—Vancouver's fun fair is filled to overflowing with fanciful bits and pieces of aerospace lore and hardware. Munch lunch at a taco stand shaped like a spacecraft! See a Moon Rover!

**Solar Science**—Forty years of studying the sun has yielded a harvest of knowledge about the star that shines brightest on Earth.

**Airplane Faces**—Something even your mother will love: Carl Posey's fancy turns to various airplanes' personalities as seen nose-on.

Patrick Ward

**Down-Under Doctoring**—Feeling poorly? Call one of Australia's flying medical teams. Once a curiosity and now a national institution, the country's airborne medics reach the most remote parts of the sparsely populated interior.

**Windmills, Windmills**—In parts of California, they're everywhere, they're everywhere. Born out of the oil crunch (and special tax provisions) of the 1970s, wind power is now on-line and providing as much power as one good-sized nuclear plant—but without the nuke's risks. And depending on the eye of the beholder, some of these wind farms are even beautiful.

**Solid-Fuel Rockets**—Kurt Stehling's primer on the design of "solids" is especially timely in light of the interest that has focused on the boosters used on *Challenger* and other rockets. History reminds us that solid fuel powered the first rockets, only to lose favor to liquid fuels for a time until it was "rediscovered" for use in submarine-launched missiles.

**Mars Maps**—Where to get 'em? From the U.S. Geological Survey, of all places. It turns out that Earth mappers do a pretty good job of charting the other planets as well, as this visit to the agency's Flagstaff, Arizona, map factory reveals.


DEWAR'S PROFILE:
ALISTAIR BALLANTINE
HOME: Mombasa, Peking, Cairo, Delhi, London, Edinburgh, Bangkok, Nairobi, Kuala Lumpur; with a more permanent camp in darkest Connecticut.
AGE: 37
PROFESSION: President, Abercrombie & Kent Safaris, Inc.
HOBBY: Elephant polo at Tiger Tops in Nepal. "Once you know how, it doesn't get easier."
LAST BOOK READ: *Journey Without Maps*, Graham Greene.
LATEST ACCOMPLISHMENT: Organizing a balloon safari over Mt. Kilimanjaro. "Why climb when you can ride?"
WHY I DO WHAT I DO: "Because it's there."
QUOTE: "Boredom is perhaps the one thing everybody can do very well without."
PROFILE: Adventurous and enthusiastic. Has a real talent for getting others to see the world his way.
HIS SCOTCH: Dewar's® "White Label"® and soda. "Dewar's has always been first on my list of civilized necessities."
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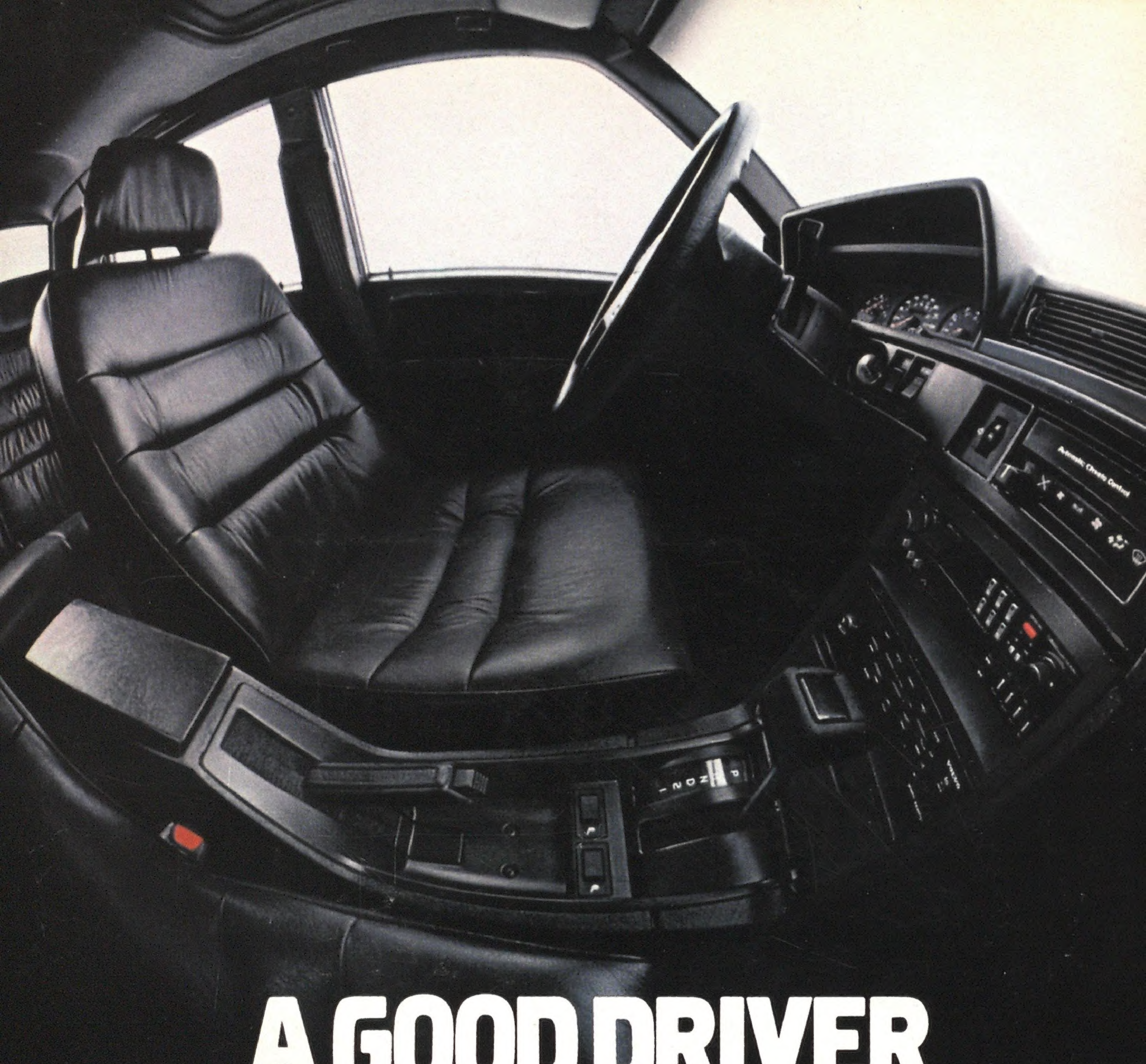

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